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THE COPPER QUESTION.

M. SECRETAN has spoken, and we may now form some idea of what the position in regard to copper is likely to be for a long period hence. M. Eugene Secretan is the managing director of the Société des Metaux, and it is he who has been the leading spirit in the "cornering" operations which have caused the abnormally rapid rise in the price of copper. He has been interviewed by a representative of the *Pall Mall Gazette*, and has sought to correct the construction which most consumers, if no one else, have put upon the actions of his party. Indeed, he asserts that their only purpose has been a purely philanthropic one—"that every miner, dealer, or manufacturer, should have fair remuneration for his work." They want, in short, according to M. Secretan, to put the copper trade on a sound and healthy basis, which, in his view, it has not been for a good many years. Prices had fallen much too low, below a paying level. Tough copper at one time fetched £125 a ton, and as late as 1872 Chile bars realised £110, but last year they fell as low as £38 10s. per ton. The supply had been excessive. At length many mines had to be closed, and others were worked at the barest margin of profit. This was the state of things M. Secretan set himself to remedy. There is no intention, he says, on the part of those for whom he is acting to carry the price to an excessive level; his opinion is that the present price is a fair one, and one which will benefit hosts of people, for high prices up to a certain point mean high wages to every one engaged in the metal trade. Regarding 10 per cent. as a fair return upon the capital invested in an enterprise involving many dangerous contingencies, he thinks that there are many mines which could not pay that rate of profit even at present prices. A steady, moderate price would not check consumption, he thinks; but speculation and uncertainty would. Their aim is to prevent an unnecessary output; yet he admits that high prices stimulate production. Maintenance of the present level, however, in his view, would not prevent the use of copper for any purpose to which it is now put, and, moreover, consumption is bound to increase by the advance of telegraphy, telephony, and electric lighting. That sounds plausible enough; but can M. Secretan not see that telegraphy, telephony, and electric lighting, the growth of which has been slow enough as things are in Europe, in England particularly, is likely to advance still more slowly in future if one of the most expensive and most largely needed items is to cost about twice as much as it has done for years past? If the price of copper is maintained at, say, £90, the electric light, instead of being rendered cheaper, will prove even more expensive to instal than hitherto, with the result that the consumption in this direction will not be largely increased. One result will doubtless be that iron wire will again come to the fore for purposes for which, during recent years, it has been partially supplanted by hard drawn copper. M. Secretan looks to the extension of railways and telegraphs to China and other Eastern countries to counteract the effect upon the balance of supply and demand which the opening of new mines may cause. It is just possible that, so far as China is concerned, she may herself supply all the copper that may be needed for her railways and telegraphs—and telephones, for there are rumours of renewed activity in several quarters within her own borders where copper mining has in past times been carried on. It is satisfactory to learn from M. Secretan that he does not anticipate any large increase upon existing prices, and that he believes, apparently upon second thoughts, that from £75 to £80 per ton will be the normal price of the future for copper.

THE ELECTRIC LIGHT AT LEAMINGTON.

SOME further details of this installation have been forwarded us, and while we do not guarantee the absolute accuracy of all the details, we believe the information as a whole sufficiently authentic to place before our readers. From the reports which have reached us, it would appear that the system, at least so far as the conductors are concerned, is in a most lamentable condition. Scarcely a night has passed without the extinction of the light at some part of the system, and during the whole of one week portions of the town were plunged in total darkness, the electric light failing completely.

It seems that the town authorities are greatly perplexed as to what course they should adopt, as so far all efforts to ameliorate the condition of affairs have proved unavailing. The Mayor, however, with a sublime confidence in the ultimate success of the adventure, exhorts his confrères to patience and to take heart of grace. His reference to the repeated failures of the electric light as being due to a "trifling defect," is a judgment, to say the least, considerably tempered by mercy. We learn that the failures are ascribed to an "intermittent electrical short circuit," and that the conductors, when tested in the morning, give perfectly satisfactory results, although interruptions have occurred during the previous evening. The fault has hitherto proved a veritable "Will o' the wisp" baffling all attempts at localisation, and large portions of the conduits have been taken up in unsuccessful endeavours to capture this Leamington edition of "Friar Rush." The system of conduits and conductors has been described to us as having been carried out on the following lines:—The conduits are constructed of brick and cement, and at intervals along their inner faces

bricks or tiles project two or three inches, some space being left between them and the floor of the conduit. These projections support slate slabs 3 inches wide by 1 inch thick, and on these slabs the conductors are carried. To prevent any lateral movement, wooden bridges, with notches or grooves cut in the under side to receive the leads, are placed on the slabs. The conductors are insulated with a coating of some bituminous compound, protected over all with a tape or tapes laid on spirally.

If this description be accurate, we are not much surprised at the failure of the installation. Even rubber covered leads, far superior to those under notice in every mechanical and electrical attribute, would scarcely be laid down in such a rough-and-ready fashion. When the heavy cost of constructing conduits is considered, not to mention the outlay for lamps, dynamos, engines, boilers, and buildings, it certainly seems money thrown away if the efficiency of the whole system is to be jeopardised by a mistaken economy in the quality of the leads.

SINCE the above remarks upon the Leamington installation were put into type we have been informed that the defect in the conductors has been discovered. It appears that two of the main cables had become "disarranged" and fused. This probably means that the wooden bridge used to keep the cables apart had in some way been removed, permitting contact between two of the cables; our remarks, however, upon the quality of the insulation seem, from this, to have proved correct.

THE *Echo*, in answer to a correspondent, discusses the question of the proposed electric locomotive which has been suggested for working the underground railway traffic. We notice that magnetic attraction has been mentioned, as well as mere weight, to secure the necessary adhesion to the rails, but we doubt whether this will be seriously entertained. The late Richard Werdermann experimented long and exhaustively in his day to devise a method of magnetic adhesion which should become the equivalent of weight in the locomotive, but he met with nothing but failure, notwithstanding that the trials were carried out with real rails and locomotive wheels. Naturally we do not go so far as to say that improved methods of procedure may not be forthcoming, but the result of all Mr. Werdermann's endeavours in this direction simply went to show that the pull necessary to separate the wheel from the rail when under the influence of powerful magnetic attraction never reached one ton, and rarely exceeded half. The area of adhesive surface between an engine wheel and a rail is vastly different from that between the armature and magnets of Major King described in another paragraph.

THE stand which Messrs. King, Brown & Co., of Edinburgh, have taken against the Anglo-American Brush Electric Light Corporation will probably cause quite a little flutter of excitement amongst dynamo manufacturers. Assuming that the question of the rights of compound-winding are discussed and decided in a Scottish court of law, it will not, of course, affect the matter in England, although if the Edinburgh firm should win the case the prestige attaching to such a result must naturally influence any lawsuit in our own country. Our opinions on the subject are well known, and leaving alone its legal or moral aspect, we should not be sorry to see a test case instituted, from purely scientific reasons.

SIX months ago it was reckoned that there were 100,000 arc lamps burning nightly in America, and that the earnings averaged about 40 cents each per evening for, say, 330 nights in the year. This would yield $13,160,000 per annum. Allowing 75 per cent. expenses, this would be $3,290,000 on a capital of about $35,000,000, or not quite 10 per cent. per annum. Probably by the present time the number of arcs has been increased by several thousands. The business in carbons for these alone must be simply enormous in the States. At the same date there were over 750,000 incandescent lamps in use. Would that such progress could fall to the lot of English manufacturers!

A SCHEME is on foot for amalgamating all the telephone companies in England. The idea is, we believe, to facilitate inter-communication between towns, and to form a strong combination against any opposition, including that of the P.O. It is also thought that the expenses attached to telephonic operations might be reduced if directed from one centre. The proposition will doubtless end without anything definite being accomplished, and so much the better from nearly every point of view.

MAJOR W. R. KING, of the Engineer Corps, United States Army, has inherited the partiality of his famous countryman, Henry, for experiments in the construction of huge electro-magnets, and has recently utilised for the purpose a pair of large cannons wound with an old torpedo cable. Henry's experiments had an important bearing on the early progress of the telegraph; but it is not clear in the account from which we derive our information what object Major King has in view. Still the experiments he has conducted are very interesting, and may open the way to useful applications. The guns used were 15-inch Rodmans, weighing 50,000 lbs. each, so that the entire mass of iron, including guns, carriages, armatures, and so on, must weigh about 130,000 lbs. The cable consisted of 40 small insulated wires, a total length of eight miles of wire being employed. There was not sufficient wire at hand to enable the Major to give the length called for by theory, and he thinks it probable that a different form of coupling from that adopted might give better results. There are three coils on each gun; the coupling on each is in parallel and the guns are in series. The armature was made of 15 plates, each half an inch thick and eleven inches wide, or 82 square inches cross-section. It should have been twice as heavy, as also should have been the pile of rails that connected the guns at the breach. Nevertheless, the power of the magnet was enormous. Four 15-inch shells, each weighing 320 lbs., were held suspended from one gun, and it required a strain of 20,600 lbs. to remove the keeper when the current, which was furnished by a 20-arc light Weston dynamo, was on. The lines of force were very appreciable when a piece of iron was held in the hand, 5 or 6 feet distant from the poles, and some very interesting points were noticed, among which was a neutral point about 7½ inches from the face of the muzzle of each gun.

Small pieces of wire were projected outward with considerable velocity, and then drawn back after reaching a point some 2 feet from the muzzle. Watches were of course stopped when accidentally brought near the guns.

"FOUR minutes instead of four months—that is the measure of the shrinkage of this plastic world beneath the magic touch of the electrical engineer." Thus the *Pall Mall Gazette*, in commenting upon an epoch in telegraphy and in the history of its own enterprise. Mr. Henry Norman, at Vancouver, on the shores of the Pacific, held converse for a period of three hours with Mr. W. T. Stead in London. Both gentlemen are members of the staff of our contemporary: Mr. Stead is its editor, Mr. Norman its travelling special commissioner, who is on a journey round the world. The conversation was effected through nearly 8,000 miles of telegraph wire, made up of 140 miles of overhead wire from London to Weston-super-Mare, 329 miles of cable from Weston-super-Mare to Waterville, Ireland, 2,750 miles of cable (Mackay-Bennett) from Waterville to Canso, Nova Scotia, and 4,400 miles of overhead wire from Canso (New York and Canadian Pacific Railway) to New Westminster, Vancouver. The achievement was a notable one, and our contemporary is justly proud of it. So are we.

IT is impossible to take up any American technical journal wihout being struck by the very extended application of electricity for lighting, motive power in factories, tramcar motors, and fire alarm purposes. With reference to the last-mentioned object a comparison between its almost universal employment in the States and its exceptional use in England, is certainly remarkable. When it is considered that at precisely the most important moment, that is, the inception of a fire, warning is given by the use of automatic fire alarms, it seems strange that their employment in this country is not more general. It is not difficult to appreciate that a few seconds one way or the other at the commencement of a fire may result in its either becoming terribly destructive or, on the other hand, speedily extinguished.

SEVERAL of our metropolitan and provincial news contemporaries are much concerned just now over electric methods of punishment. They all have a jocular word to say about the electric birch, but most of them seem a little puzzled by the suggestions for putting criminals to death by electricity. One paper laments Mr. Edison's refusal to have anything to do with the subject "on principle," as though there were not another electrician in the whole wide universe.

OUR suspicion that bad workmanship and cheap construction have had a great deal to do with the numerous accidents recently caused in the United States by the electric current is justified by the remarks of the New York *Electrical Engineer*, which, in its last issue, gives "A Timely Word of Caution" to its readers. We hope they will not take the advice tendered as an insult. At any rate, there was need of it. Nothing can be more certain, says our contemporary, than that almost without exception the casualties which have occurred are due to the reckless manner in which unprotected conductors, charged with death-dealing electric currents, are placed in public thoroughfares, and in the vicinity of telegraph, telephone, and other domestic service wires. Flagrant examples of the dangerous practices condemned may be met with in New York. But the *Electrical Engineer* thinks that a marked change for the better is observable. We trust this change will continue to take place until change can no longer be for the better.

ELECTRIC street railways, according to the contemporary to which we have referred in the preceding paragraph, are not free from the defects which result from the attempt to work cheaply; indeed, some recent lines are notable examples of "how not to do it." The opinion is quoted of a well-known manufacturer of street locomotives, who exclaimed that it was useless for him to estimate for electric machinery, as he had found by experience that electrical people would not pay for the quality of workmanship that was required for proper locomotive running gear. We fear some of our friends on the other side are a little over-anxious to prove that electric railways are cheaper than steam, cable, or horse-drawn cars; they should remember that it is the falsest kind of economy to purchase or erect, at however small a cost, that which will not stand the wear and tear of ordinary usage. A curious fact in this connection is that, not content with putting poor material and workmanship into their lines, many electric railway people claim for electricity ability to accomplish that which no one would dream of attempting with steam or horses. Braggadocio!

WHY are arc lamps persistently said to be of 2,000 C.P., when it is well known that they actually fall far below that illuminating power? This is a query which has often been put, and the only explanation vouchsafed hitherto has been that the light from the lamps was measured in four directions at once, the results being added together. This would indicate 500 candles as the true power of the lamps, but this certainly falls short of the actual illumination of most types of the arc. Another cause for the assumption that 2,000 C.P. was the light given has been assigned recently in the *Scientific American*. At the present time the ends of the carbons in arc lamps are maintained opposite to each other, and the two carbons are kept accurately in line. Hence an equal or nearly equal light is given in all directions. The first use of the arc lamp was for purposes of projection. For this purpose the carbons were kept slightly out of line with each other, so as to concentrate the light in a determined direction. The crater formed in the lower carbon faced in one direction, and in that line most of the light was emitted. At the back of the lamp the light was far less. If the same carbons were placed in alignment, a more even distribution of light would result, but it would be far less, in the ratio of 2·83 to 1, than it was in the former arrangement in the most favourable point. Thus a lamp which, with the old arrangement of carbons, would project a light of 2,000 candles in one direction, with the same carbons aligned would only give $\frac{2000}{2\cdot83}$, or a little over 700 candles. The light from the old type of lamps was measured in the most favourable direction. Whether this be the correct explanation of the anomaly or not, it is high time a more correct method of computation was adopted, and that contracts should specify lamps of actual candle power.

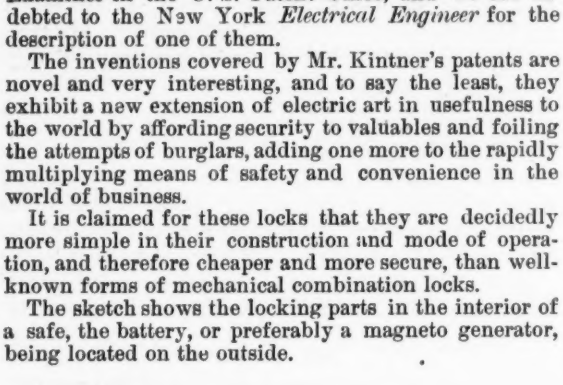
APPLICATION OF ELECTRICITY TO LOCKS.

A SERIES of electrical combination locks has been recently patented by Mr. C. J. Kintner, late Principal Examiner in the U. S. Patent Office, and we are indebted to the New York *Electrical Engineer* for the description of one of them.

The inventions covered by Mr. Kintner's patents are novel and very interesting, and to say the least, they exhibit a new extension of electric art in usefulness to the world by affording security to valuables and foiling the attempts of burglars, adding one more to the rapidly multiplying means of safety and convenience in the world of business.

It is claimed for these locks that they are decidedly more simple in their construction and mode of operation, and therefore cheaper and more secure, than well-known forms of mechanical combination locks.

The sketch shows the locking parts in the interior of a safe, the battery, or preferably a magneto generator, being located on the outside.



A series of insulated wires, say 50 in number (in the sketch shown as 14), lead from the exterior of the safe to a switchboard within, all of these wires being electrically connected to such switchboard, as shown, save in this instance, numbers 3, 9, 10 and 12, which are insulated therefrom by washers and have continuing conductors, W, W^9, W^{10}, W^{12}, and W^{17}, all leading to a common binding post, V, the wires, W^9, W^{10}, and W^{12}, being connected respectively through the electro-magnets or solenoids, M, M', M^2, while the separate conductor, W^{17}, runs from the switchboard to and through a safety magnet, M^3, to the same binding post, V. The wire, W, answers as a return wire for all four of the wires, W^9, W^{10}, W^{12}, and W^{17}.

X and Y are shunts normally closed about the magnets, M' and M^2, by the springs, K' and K^2, lying in the path of the lugs, l and l', on the armature levers N and N'; S, S', S^2 are retractile springs for holding all the levers in their locked positions.

N^4 is a safety lever pivoted at P^3 and having a soft rubber spring, n, on its short arm bearing against the locking lever, N^3, so that when said lever is drawn up by the action of the solenoid, M^3, it will tend to hold locking lever, N^3, in its locked position, and at the same time cause its hooked end, p, to engage the hook, p', on lever, N.

The shunts X and Y unite at q, and pass thence in a direction about the core of solenoid M^3, the reverse to that of the main coil joined to W^{17}, so that if the circuit is closed at 10 or 12 through any other number outside the safe this safety magnet will be actuated and permit the operation of the lock. The outer ends of the insulated wires lie beneath two horizontal metal rods (not shown), one of which is attached to the plus pole of the battery and the other to its minus pole. On one of these bars is a sliding contact maker, and on the other are three similar to the first, all of which are adapted to connect the contacts lying under them directly to the battery as they are slid along across the outer face of the safe door.

The operation is as follows:—The combination numbers are in this instance 3, 9, 10 and 12, being chosen from a series of 14 numbers; while the other 10 numbers are connected to the safety circuit by direct contact with the switchboard and wire, W^{17}.

To open the lock, place the contact maker of, say, the lower horizontal rod attached to the face of the safe upon the exterior contact point 3; next place any one of the three contact makers of the upper horizontal rod on point 9. The battery circuit will then be closed from the copper or plus pole as shown by the arrow at 9, to and through insulated wire number 9 to the inside of the safe, and thence by wire, W^9, magnet or solenoid M to post V, by wire, W, to point 3, and finally to the exterior of the safe and minus pole of the battery, as shown by the arrow.

This energises the solenoid, M, and causes its core to turn the lever, M, about its pivot, P, against the action of spring, S, and to bring the lug, l, into mechanical contact with the spring, K', thus breaking the shunt, X, to the second magnet, M', of the combination, and at the same time drawing the hook p', out of the path of the hook p on the safety lever, N^4.

Now cause the second contact maker of the upper horizontal contact rod to be placed upon the point 10, the second number of the combination, and the battery will be closed in multiple arc by the path already described, and a second path from point 10 by wire 10 through the door to inner point 10, and wire W^{16} to and through magnet or solenoid, M', thence to common point, V, and out by wire, W, as before. Magnet or solenoid, M', is energised, causing lever, N', N^2, to tilt about its pivot, p', so as to carry the lower end to the left out of the path of the locking lever, N^3, and at the same time cause the upper end, N^2, to mechanically lock the lever, N, which now extends into the opening, h.

This same action breaks the shunt, Y, of the last locking magnet, M^2, at the spring, l^2, by means of lug, l^1, on lever, N'.

The first circuit may now be broken if desired. The last circuit is now closed by placing the last contact maker on the upper horizontal contact rod in contact with the point 12 beneath it, when the circuit is again closed through the additional multiple arc branch, W^{12}, magnet, M^2, and common return wire, W, thus causing the last or locking lever, N^3, to be drawn up against the action of spring, S^2, and out of the path of the lug, G, on the bolt frame, F'.

The bolts may now be drawn by turning the bolt handle (not shown) in the usual manner, and this lug, G, will be forced to the right under the raised end of the locking lever, N^3. The circuit may now be broken at point 3 and the combination contact maker slid along to any desired position on the horizontal rods which support them. These rods are not shown in the sketch. On returning the bolts into locking position, the locking lever, N^3, and the levers, N^2, N, all fall into locking position under stress of their springs, S, S', S^2.

If the circuits be closed in any other order than that indicated, the safety magnet, M^3, will be actuated and cause its lever, N^4, to firmly hold the last locking lever in position, and at the same time lock the lever, N, against action.

The arrangement is such that each armature lever locks its companion, and they all in turn lock the bolts.

In the simplest form of lock made by Mr. Kintner, the shunts are omitted, thus avoiding liability of derangement of contacts on the inside of the safe. He is building a safe with such a lock, and will place it on exhibition within a month.

It will be seen that this lock simplifies the operation of entering safes very materially, and it is found that four seconds at the utmost will suffice to draw the bolts.

SIEMENS AND HALSKE'S SYSTEM OF COUPLING ALTERNATE CURRENT DYNAMO-ELECTRIC MACHINES.

IF two or more alternate current dynamo machines are required to send into one common outer circuit a steady current equal to the sum of the currents which each machine would deliver singly into the same circuit, the following conditions must be complied with: Firstly, the difference of potential at the terminals must be of the same value in all machines connected in parallel arc, and, secondly, the current impulses must coincide with each other in all machines connected in parallel arc.

The equalisation of the difference of potential at the terminals can be effected by known methods, so that the first question presents no serious difficulty, but the second condition is not so easy of solution. Experiments have proved that the currents of two or more alternate current machines when first connected in parallel arc do, as a rule, not coincide even when the machines are of precisely the same construction and are driven from one and the same shaft.

After a certain lapse of time no doubt coincidence occurs, for so long as the current impulses of two machines do not coincide, the machines receive impulses from each other which are added to the self-generated impulses in the case of opposite phases, or are subtracted therefrom in the case of phases of the same direction; in the first case both machines are subject to retardation, in the second case, on the other hand, the first machine is retarded and the second accelerated, so that the phases tend to coincide. The same thing then again occurs, but in the opposite sense, as the first machine will then be accelerated and the second one retarded, so that the phases will recede from each other. As, however, the extent of the first-named approach of the phases exceeds that of the recession, it follows that by a continuance of these fluctuations there will be a gradually-increased approach of the phases until at last they coincide.

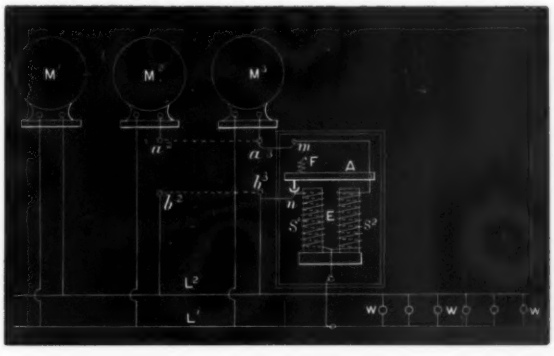
During this period any lamps or motors connected to the outer circuit would work very irregularly; it is, therefore, not practically feasible to work alternate current machines in parallel circuit by coupling them, one after the other, to the outer circuit, even if the polar tension is of the same value in all such machines.

The object of Messrs. Siemens and Halske's invention is to avoid this difficulty, and consists in the employment of means whereby the alternate current machines that are to be coupled to a circuit already charged by one or more other such machines are automatically coupled at the moment when the impulses coincide. For this purpose, assuming that one alternate current machine is connected to and charging the outer circuit, and that a second one is to be coupled up when its impulses coincide with the first, a horse-shoe electro-magnet is employed, the coil on one limb of which has its two ends connected respectively to the two leads of the outer circuit, while the coil on the other limb has its one end connected to the one lead of the outer circuit and its other end connected to the one terminal of the second machine, whose other terminal is connected to the same lead of the outer circuit as that to which the one end of the last-named coil is connected, so that the coil of the second limb is practically connected with both ends to the two terminals of the second machine.

The electro-magnet has an armature held away therefrom by a spring or weight, which armature is electrically connected with that terminal of the second machine which is directly connected to the coil on the second limb of the magnet, while on the attraction of the armature by the electro-magnet it is caused to make a contact whereby the said terminal of the second machine is electrically connected to the second lead of the outer circuit, thus including the second machine in the circuit.

The fig. shows diagrammatically the arrangement of this electro-magnet in connection with an alternate current machine, M^1, which is permanently connected to the leads, L^1, L^2, of the outer circuit, W, and a second alternate current machine, M^2, arranged in parallel arc to M^1, which is to be coupled up with the leads, L^1, L^2. E is the electro-magnet, the two ends of the coil of whose limb, s^1, are connected respectively to the leads, L^1 and L^2, while the ends of the coil of limb s^2 are connected respectively to the lead, L^1, and to the lead, a^2, or, in other words, they are connected to the two terminals of the machine, M^2, as L^1 is connected to the one terminal thereof, and the lead, a^2, is connected to the other terminal.

The coil of s^1, therefore, has a current passing through it, which is supplied by the machine, M^1, and which is proportional to the difference of potential between the leads, L^1 and L^2: the current passing through the coil of s^2, on the other hand, is proportional to the difference of potential between the terminals of the machine, M^2.



So long as the current impulses of the two machines do not coincide, the magnetic forces of the two limbs, s^1, s^2, act to a certain extent in opposite directions, and consequently weaken each other so as not to be capable of attracting the armature, A. But as soon as, by the influence of the machine, M^1, upon the machine, M^2, a coincidence of impulses is brought about, the magnetic force of the electro-magnet will be equal to the sum of the magnetic forces produced in s^1, s^2, when it will be sufficient to attract the armature, A, against the opposed action of the spring, F. The armature will then make contact at n with the connection of coil s^1 through b^2 with the main lead, L^2, and as the armature is also connected with the terminal, a^2, of the machine, M^2, it follows that this terminal will now be coupled up with the main lead, L^2. As both coils of the electro-magnet are now connected with the leads, L^1 and L^2, the armature will remain permanently attracted by the electro-magnet.

In the same way, and with the same apparatus, any number of alternate current machines can be coupled up consecutively in parallel arc. For example, in order to couple up the third machine, M^3, parallel to M^1 and M^2, a^2 and b^2 are connected directly with each other, and the m a^2 and n b^2 are separated, and m is connected with a^3 and n with b^3. The automatic coupling up of the machine, M^3, is then effected in the same manner as above described with reference to M^2. Or, instead of effecting the coupling up of several machines consecutively by means of one and the same apparatus, they may all be coupled up simultaneously by means of separate apparatus to each machine.

In place of the electro-magnet with two limbs, one with a single limb or core, having two coils connected as above described, may be employed; also, instead of using an electro-magnet with polarised or non-polarised armature, a solenoid formed of two insulated coils with iron core may be employed, or lastly, there may be used two solenoids with or without cores, so arranged relatively to each other that on the coincidence of the impulses occurring a mutual attraction or repulsion takes place sufficient to overcome the opposing force of a spring or weighted contact-piece.

ON THE PRODUCTION OF VERY GREAT AND ACCURATELY KNOWN RESISTANCES, AND ON AN ARRANGEMENT OF RHEOSTAT RESISTANCES.

By F. KOHLRAUSCH.

IN galvanometry it is often required to divide a current into two very unequal branches. This is in particular often demanded in referring the constant of a very sensitive multipler to that of a normal galvanometer, which has been proposed also by Dorn for the determination of absolute resistance. The author was engaged in producing a branch relation of about 1 : 1,000. Even if such a proportion were accurately known to its 10,000th part the use of an ordinary rehostat presents great difficulties. It is, especially, almost impossible to regulate the proportion with the required accuracy in a short time as it may be necessary, on account of the heat developed by the current and other causes of fluctuations of temperature.

There is a very simple means of regulating resistances, amounting to 16, 81, 256, 625, 1,296, &c., or, indeed, to n^4 if n is a whole number, and that with all the accuracy which is possible in comparing resistances and of determining them at any time by a single comparison of two nearly equal resistances. Let there be given :— firstly, n equal resistances w; secondly, n equal resistances W, and let W be approximately equal to $n^2 \cdot w$. If the w are introduced in succession, and the W parallel, there are produced resistances approximately equal, namely, $n \cdot w$ and W/n, which may be accurately compared according to one of the known methods. Suppose we thus find $\frac{W}{n} = n\,w\,(1 + \delta)$. If we then introduce the w parallel to each other and the W in succession, we have, on the one hand, the resistance w/n, and, on the other, $n\,W = n^3\,w\,(1 + \delta)$. The proportion of both to each other is $n^4\,(1 + \delta)$.

Here we do not require an absolute equality of all the resistances of two groups, but the differences may amount to a few parts per thousand without the result being appreciably interfered with even for the most exact purpose.

The requisite comparison can be effected in a minute with the needful instrumental preparations.

In addition to this most simple method, the introduction of parallel and successive resistances can naturally be often utilised. For the sake of convenience, general applicability and convenience, I have come upon the following arrangement, the mechanical execution of which has been undertaken by Herr Siedentopf, of Würzburg.

Groups of ten resistances, each of 1 ohm, 100 ohms, and 10,000 ohms (the thickness of the wire being 1·2, 0·5, and 0·1 mm.), are arranged in three rows beneath a plate of vulcanite of 2 cm. in thickness. Each resistance terminates in the mercury cups, well fitted into the plate. In order that the mercury may not ascend over the margins, these cups are made of steel. After they have been thinly tinned beneath, and for about two-thirds of their height within, the copper connecting rods (4 mm. in diameter) may be securely soldered on with their broad end surfaces, and the cups are then well amalgamated within and lacquered without.

The plate of vulcanite is fixed, as in a Siemens rheostat, like the lid of a wooden box.

The introduction, either in succession or parallel, is effected by means of amalgamated copper arches 6 cm. long and 5·5 mm. in thickness. The resistance of such an arch is about 0·00005 ohm. This value can be ascertained with sufficient accuracy by introducing a great number of such arches in succession.

It is scarcely necessary to explain how very different resistances may be obtained with this rheostat. Even a proportion of about $1 : 10^6$ $\left(\text{namely } \left[\frac{1}{10}\right] : \Sigma\ 10{,}000\right)$ can be regulated in a few minutes with the complete accuracy which is attainable for comparisons of resistances.

As an illustration I will work out the examination of the proportion of 1 : 1,000, which may be obtained as 0·1 : 100, 1 : 1,000, 10 : 10,000, or 100 : 100,000. We will take 10 : 10,000.

In order to determine the real proportion we compare the ten thousands $\left[\frac{10{,}000}{10}\right]$ introduced parallel with the hundreds $\Sigma\,[100]$ introduced in succession, and then the ten thousand used $10{,}000_0$ with the remaining $10{,}000_1 \ldots 10{,}000_9$.

Let the first comparison show

$$\left[\frac{10{,}000}{10}\right] = \Sigma\,[100] + \Delta.$$

Then

$$\Sigma\,[10{,}000] = 10{,}000 \cdot \left(1 + \frac{1}{1{,}000}\,\Delta\right) \times \left[\frac{100}{10}\right]$$

Further let there be found

$$10{,}000_1 = 10{,}000_0 + \delta_1$$
$$10{,}000_2 = 10{,}000_0 + \delta_2$$
$$10{,}000_9 = 10{,}000_0 + \delta_9$$

We put $\quad \delta_1 + \delta_2 + \ldots + \delta_9 = \Sigma\,\delta$

Then evidently

$$\Sigma\,[10{,}000] = 10 \cdot 10{,}000_0 + \Sigma\,\delta$$

or

$$10{,}000_0 = \frac{1}{10}\left(1 - \frac{1}{100{,}000}\,\Sigma\,\delta\right) \times \Sigma\,[10{,}000]$$

If we put for $\Sigma\,[10{,}000]$ the value obtained above, we have

$$10{,}000_0 = 1{,}000\left(1 + \frac{1}{1{,}000}\,\Delta - \frac{1}{100{,}000}\,\Sigma\,\delta\right) \times \left[\frac{100}{10}\right].$$

The proportion of resistance sought for is therefore

$$10{,}000_0 : \left[\frac{100}{10}\right] = 1{,}000\left(1 + \frac{1}{1{,}000}\,\Delta - \frac{1}{100{,}000}\,\Sigma\,\delta\right).$$

There was further required the branch proportion 1 : 900. Nine of the ten thousands were introduced in succession and the sum of these was introduced parallel with the tenth ten thousand. This represents 9,000 ohms which, in comparison with the hundreds introduced in a parallel manner, give the proportion required. The corrections are similar to those given above.

All requisite comparisons can be effected in less than five minutes by a process of interpolation. This is of importance for fine measurements since otherwise the unavoidable changes of temperature cannot be accurately checked.

For the ordinary purposes of a rheostat this arrangement is more serviceable than it may appear at first sight. With 10 equal resistances there may be constructed by proper combinations 94 different resistances within the interval from 1 to 100. The additional use of the other groups in a successive or a parallel arrangement the number of combinations can naturally be very much increased, so that we have approximately most resistances at disposal.

As a matter of course there can be no intention of superseding the very convenient arrangement of Siemens as far as ordinary purposes are concerned, but when accuracy has to be carried very far our arrangement will prove decidedly more useful.

The advantages of the arrangement: The comparison of resistances has at its disposal means which in accuracy are of equal rank with the use of the balance. Rheostats can be furnished of as high accuracy as weights. Still, practically we are rarely in a position to carry out with the rheostat a determination of a resistance which can be guaranteed to $\frac{1}{10000}$. The causes lie in the following circumstances :—

1. The temperature of the coils of wire follows the temperature of the air very slowly. Even if a thermometer is used in the box we are often uncertain to 1° C. or more in consequence of the varying temperature of our rooms. 2. This disadvantage is aggravated

by the fact that coils differing in thickness and in other respects undergo an unequal retardation of temperature. 3. The currents heat the coils. The hindrances 1 and 2 are objections in particular to the use of very thick wires. 4. Low and high resistances are not made of the same sort of wire, and evince, in fact, differences of 0·0001 in the coefficient of temperature. If these differences are ignored, errors up to $\frac{1}{1000}$ may be produced. 5. The resistance of the coils varies in time, and to an unequal degree, with different kinds of wire and manners of coiling. 6. The plug introduction, which is excellent if only a degree of accuracy of 0·001 ohm is required, must be very cautiously treated if 0·0001 ohm is required. Even the great expansion of the vulcanite by heat involves a source of error for altering the form of the holes. 7. In older arrangements there come in addition errors of conduction by the use of common plugs, which are sometimes considerable, and which have been pointed out by Dorn.

The arrangement described above presents evidently the following advantages:—There are, in the first place, only three groups of different coils. In each group all the coils are of the same nature, and may be regarded as identical as to the retardation of temperature and the temperature coefficient. As, moreover, the by-circuit is employed for small resistances, we have the advantage of a larger mass, and yet of a relatively large surface. The temperature becomes more quickly like that of its surroundings than when single thick coils are used and the heat of the current is decreased.

A comparison of the resistances among themselves can be more readily effected than with the ordinary rheostats. Indeed, when once the rheostat has been calibrated it is sufficient, in order to eliminate temporary disturbances from a change of temperature, to make a reciprocal comparison of the three groups (which, in fact, consists of only two examinations of equal resistances) in order to make all things comparable.

As the last advantage of the arrangement must be mentioned the applicability of all the resistances separately or in any desired combination. The modern methods of galvanic measurement often use branch currents. The problem, *e.g.*, of closing a battery by a strong resistance and taking a branch current from an exactly known part of the circuit which again contains a known re-resistance cannot be solved with an ordinary rheostat, whilst with our arrangement any required combination is possible.

Plugs also can be readily arranged, but the resistance of the circuit is then greater and more uncertain. I found in a Siemens rheostat the resistance of a plug $= \frac{1}{4000}$th ohm, whilst that of an amalgamated copper arch was only $\frac{1}{20000}$th ohm.

TRANSMITTING SPEECH BY INTERRUPTED ELECTRICAL CURRENTS.*

(*Concluded from page* 57.)

THE contact telephone which depends for its mode of operation upon the variation of the actual contact surfaces between the electrodes, differs from the magneto instrument in that the currents always move, so to speak, in one direction, there being only a rise and fall or change of volume due to a constant electromotive force or tension and a varying resistance, the effect on the receiver being the equivalent of the reverse currents, which arise in a magneto transmitter.

A diagram representing the current waves of such a transmitter will therefore be unnecessary, it being understood that such a diagram would show simply increased and decreased volumes for the overtones and fundamentals due to a current of constant electromotive force where the diaphragm in fig. 2 shows increased currents, decreased currents and reversals.

Fig. 1 represented diagrammatically the volumes of current for a pure musical tone when uttered into a Bell magneto instrument.

Fig. 3 represents the same for a Reis transmitter, *a*, *b*, being the medial line of the diaphragm at rest, and A the volume of current flowing under all conditions. In a word, as there are no overtones and the beats or vibrations are regular, the electrodes being of hard metal, as iridium, there will occur at the fundamental and sole dead points of the diaphragm breaks in the current in regular recurrence.

A constant volume of current will flow for all phases of the diaphragm equal to A, and electrical impulses will be set up over the line of equal volume and duration which in turn will actuate the receiver and cause it to repeat accurately this fundamental tone. It is not possible that there can be current variations between absolutely clean hard iridium contacts, for the individual molecules are so small or so compact that for the infinitesimally small power of a delicate pure musical tone, such a proposition is absurd. I think, however, if proof be demanded that such pure tones are transmitted otherwise than by individual current impulses, the Gray system of unison reeds will substantiate it.

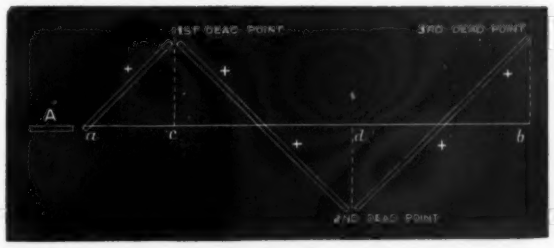


FIG. 3.

If, then, a pure musical tone can be transmitted by current impulses, why cannot composite tones? What is the difference between these two classes of tones that one can be transmitted by the Reis instrument, while the other cannot?

The composite tones differ in the main only in degree from the pure tones, and if the instrument be so modified as to meet this change of degree it will meet all the requirements necessary to transmit such composite tones. Very much has been said during the telephone controversy of tone quality and its two companion elements, pitch and intensity. It has been urged with good success, that there is an absolute necessity in the transmission of articulate speech that the timbre or tone quality be transmitted, but so far as I am aware it has never been pointed out that this tone quality is purely a matter of degree; that the voice of one person differs from another only in degree of musical purity, and that the instrument which will transmit one voice will not successfully transmit another in all its purity.

It has been the argument of the learned counsel in the Bell suits, that it was absolutely necessary that the transmitting diaphragm should so mould the electrical currents on the line as to create actual copies in the receiver at the distant station, and the magneto instrument does it beyond a peradventure of a doubt. This argument is undoubtedly correct for telephones of that type.

If, then, as I have asserted, individual voices differ from each other only in their degree of musical purity, and no one can doubt it who has listened to the smooth liquid voice of the Italian or Frenchman as compared with the guttural hoarse voice of the German; if such

* By C. J. Kintner (late Principal Examiner Class of Electricity, U. S. Patent Office), in the New York *Electrical Engineer*.

be the case, and if the Reis instrument transmits pure tones by current impulses of constant volume, then why cannot this instrument be so adjusted as to transmit such composite musical tones; and has it not been done in the past by scientists unconscious of the actual mode of operation? It is, I think, generally admitted that speech can be transmitted by the Reis transmitting apparatus, but it is urged that the Bell method is practised whenever such result is attained; that there has been current variation between the electrodes rather than actual makes and breaks, and much has been said about continuity of contact through the spark if actual mechanical separation took place between the electrodes.

In fig. 4 I have shown a diagram of the current impulses created in a Reis transmitter when adjusted to transmit the same composite sounds shown by the diagram in connection with a Bell magneto shown in fig. 2, *a*, *b*, represents the medial line of the diaphragm as before, and A the current volume.

The diaphragm is under stress and is tuned to a given pitch, that of the normal voice of the speaker, and the movable electrode is a weighted lever adjusted to vibrate in absolute unison with the diaphragm under

by $2\frac{1}{2}$ in width, held at its ends by means for regulating its tension; near its centre was a polished steel electrode. This diaphragm hung in its frame so as to adapt it to be adjusted to any angle. The loose electrode of hard steel hung from pivots like a pendulum and was provided with a pendulum bob for adjustment. By adjusting the diaphragm to a given pitch and the weight or bob on the loose pendulum electrode so that it would vibrate in unison for a given note, I found that on uttering the word "hello," into the instrument, only unintelligible disagreeable sounds were heard until I struck the key to which the diaphragm was tuned, when the attendant heard it very plainly and continued to hear it until the pitch of my voice was changed, when only confused sounds were again heard.

If the apparatus operated by the Bell method, why would it not operate when the voice was pitched in a different key? There can be but one solution of the problem, and that is, that the electrodes vibrated in unison with the key note of the voice, separating for all the radical phases of its overtones and fundamentals. It is absurd to suppose that there can be such a phenomenon as current variation due to pres-

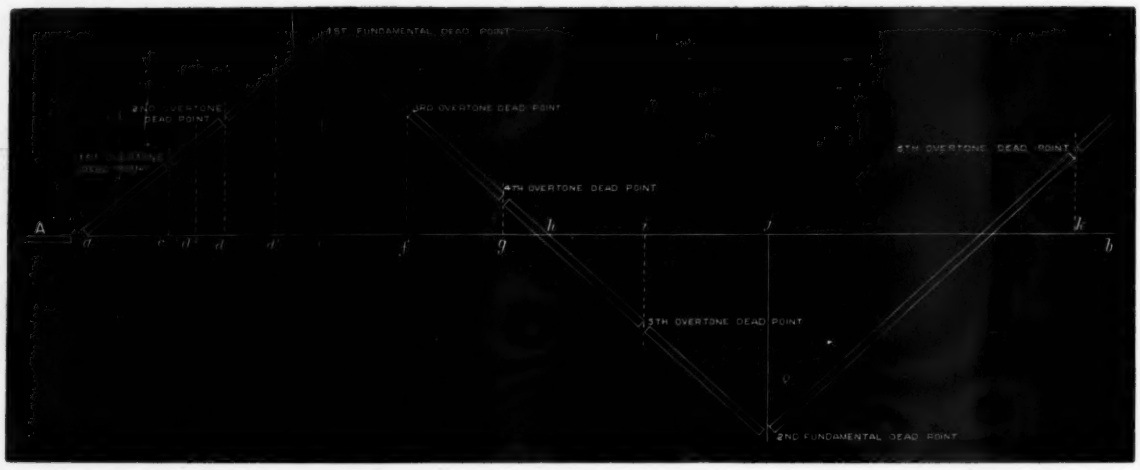


FIG. 4.

all conditions. That is to say, if the diaphragm makes 200 vibrations per second, the loose electrode of pendulum form will vibrate absolutely with it, separating from it only by virtue of its inertia, as the diaphragm tends to recede from it at the reverse overtone and fundamental dead points. As a result we have actual mechanical separations at *c* and *d* for the first and second overtones and at the first fundamental. There will be no separation for the advance overtones or such as increase or aid the fundamentals, and hence these overtones will be lost. It is true the speech may be somewhat mutilated, but for all overtones where the tendency is to decrease the fundamentals there will be a separation of the electrodes and the receiver will be affected thereby, the current volume always remaining constant and the impulses copying the reverse overtones.

It may be urged that if we neglect the advance overtones, or such as aid the fundamentals we neglect much of the transmitting current impulses, and hence mutilate the speech so as to make it more or less unintelligible.

Such is not the case, and I am convinced that with existing contact telephones it is only the action of such tones as actually check the advance of the diaphragm that gives the actual tone qualities, and that the advance, or aiding overtones, do little to modify the tones in the receiver.

The instrument used by me in my experiments consisted of a rectangular diaphragm about 3 inches long

sure between two hard polished steel electrodes under pressure of so delicate a force as the sound waves of the human voice, as it is equally absurd to suppose that there lies in the spark, if a spark does in fact exist between such electrodes when separated, an inherent self-acting force which so modifies the electrical currents as to make them of a wave or undulating nature. With a delicate microphone transmitter having variable contact surfaces, as in the Hunnings instrument, such a thing is admissible and entirely in harmony with the operation of the magneto apparatus, for in such an instrument there is clearly a change of conductivity due to this change of pressure.

Whether or not such a contact telephone as I have described is practical, is another question which need not be discussed here; the simple fact that with such an instrument intelligible speech can be transmitted by current impulses being the question under consideration. That it does it, and in the manner described is clear, and that the Reis instruments, wherever operating to transmit speech, do it similarly, is also an undoubted fact in my opinion.

Mr. I. Thornton Osmond writes to the New York *Electrical Engineer*, with reference to a point in Mr. Kintner's article:—Mr. C. J. Kintner gives a diagram and this equation for the currents produced by "a pure musical tone entirely free from harmonics," $c = \frac{v\,t}{d^2}$. If he

is going to make further use of this equation, or if the further discussion has any connection with it, I should like to have some light upon it.

Mr. Kintner says: "v may be assumed constant for any interval of time, since the power due to this particular sound wave is a constant, so that the velocity tends to be of a constantly accelerated nature, but is, in fact, opposed by a constantly increasing power—the elastic stress of the diaphragm." If a pure musical tone without harmonics is maintained in a column of air resting on a diaphragm, the energy transmitted to the plate is not constant, even during the interval of the impinging of a single condensation. It is true that the energy of the molecules of each of the successive cross-sections is constant. But this constant energy is made up of two parts—a kinetic part due to velocity of the particles, and a potential part due to their displacement from equilibrium positions. Only one of these, the kinetic part, has any effect on the diaphragm. The action of the wave on the diaphragm must be of variable "power," instead of constant. But even if it were constant, can Mr. Kintner show that the elastic stress of a plate, clamped around its edges and under uniformly distributed pressure over the central region, increases in such a way that the velocities of its parts are constant under a constant accelerating force? Again, has he taken into account all the forces acting to give the diaphragm velocity? He mentions only wave energy and elastic stress. Does not the change of magnetic induction and field intensity, as d changes, affect the velocity?

"There is generated during the advance of the diaphragm a plus current of constantly increasing volume, until the value of d has diminished sufficiently to change its volume." I do not understand how diminishing the distance of the diaphragm is to decrease the volume of the current, especially with v constant. Is not the volume of the current due directly to rate of change of magnetic force within the coil? And is not this rate of change of magnetic force some function of (a) the velocity of the diaphragm and (b) the magnetic field? Is not the diaphragm velocity a function of variable wave energy, variable elastic stress, variable magnetic stress again varied by variation of current, and variable time? Is not the magnetic field, in form and intensity, some function of the physical conditions of the core and diaphragm, the variable current strength, and the variable distance?

I would offer the following in place of Mr. Kintner's first equation:

$$c = \phi \text{ (velocity, field,)}$$
$$= \phi \begin{cases} \text{variable wave energy, variable current,} \\ \text{,, elastic stress, ,, distance,} \\ \text{,, magnetic ,, \&c.} \\ \text{,, time.} \end{cases}$$

But I have no diagram of the volume of currents to offer until I have time to investigate some, and calculate others, of the final variables.

THE TELEGRAPHISTS' SCHOOL OF SCIENCE.

THIS school, which was established 12 years ago at the Central Telegraph Office, General Post Office, by Mr. W. Slingo for the benefit of the operators and others employed in the office, has just completed its eleventh annual session. The school, which is under the management of a committee, of which Mr. T. Barlow is the chairman, is in a very flourishing condition, and under the able superintendence of Mr. W. Slingo, the Lecturer, and Mr. A. Brooker, the Instructor in Mathematics and Laboratory Practice, and Mr. H. A. Miles, the Instructor in Workshop Practice, is doing excellent work. On Friday, January 13th, a distribution of awards (73 in number) to the various workers in the school, was made by Mr. W. H. Preece, F.R.S., Electrician to the Post Office, there being also present Mr. C. H. B. Patey, C.B., Second Secretary, and several other prominent officials; the Postmaster-General was unavoidably prevented from attending. Over 100 past and present members of the school were also present. Mr. Patey in the course of the proceedings stated that the department would afford every possible assistance to the school which was doing so much good work. The first or Controller's prize, with illuminated testimonial, was gained by Mr. F. Tandy; the second or Sub-Controller's prize, with illuminated testimonial, by Mr. Jas. Bailey; and the third or Engineering Superintendent's prize, by Mr. W. J. Callow.

The committee in their report state that they have great pleasure in again being able to present a favourable and satisfactory report upon the work of the past session (1886—7).

At the commencement of the session 54 members of the staff gave in their names as students, 50 for the classes in electricity and telegraphy, and 20 for the class in mathematics. A wearying Parliamentary session again had the effect of keeping away many who would otherwise have joined.

Of those in the Electricity Class 25 sat for examination, 16 in the elementary, and 9 in the advanced stage. Of the advanced candidates two gained first class certificates and Queen's prizes, and four gained second class certificates, 13 passed the elementary examination, three of them taking first class. Six sat for examination in mathematics with the result that one gained an advanced certificate, one passed first class elementary, and three second class elementary, only one failing. In the Science and Art Department examination in Elementary Electricity, which candidates from the school underwent, the percentage of failures was as low as 18·75 per cent., 81·25 per cent. passing.

In the Telegraphy Examination, which, after all, is the proper test of the efficiency of these classes from a departmental point of view, 15 sat for the certificate examinations, 11 in the ordinary grade, and 4 in the honours. All the four honours candidates were successful, one gained a second class certificate, and three passed first class, including Mr. Frank Tandy, who having worked the best paper in the United Kingdom, was awarded the first prize, comprising a silver medal and £5. Two ordinary grade candidates failed, two took second class certificates, and seven took first class, so that 10 out of the 13 successes were of the best order. During the past four years the school has gained five out of the 26 medals awarded.

The figures for the past year as compared with those of the United Kingdom are interesting and instructive. In all 73 candidates from 24 different schools were successful, including 13 from this school. The average is only three per school.

48 took first-class certificates, 10 of them, or 20·8 per cent., coming to the school. In the Telegraphy Examination result (reports the committee) we have therefore not a single weak point to touch upon. Mr. G. F. Mansbridge, who occupies the unique position of having gained in two successive years medals in the Ordinary and Honours Telegraphy Examination, gained an honours certificate in electrical instrument making; only three such certificates were awarded throughout the whole kingdom.

The committee have also to congratulate the students upon the large number of useful prizes which have been given locally by officers of the department.

The practical laboratory and workshop classes have been well patronised and some excellent work has been turned out. It is noteworthy that the workshop, which is available at all times, tends to improve the attendance at the lectures by allowing students to make profitable use of the odd hours intervening between the expiration of their official duty and the commencement of the lectures.

Altogether the past session has been pre-eminently successful and there is every prospect that the present session will equal or even surpass it. Nearly 60 students are now in attendance and a good year's work is therefore anticipated.

In conclusion, it may be mentioned that since the foundation of the classes, in the year 1876, 353 mem-

bers of the staff have passed or are passing through the classes, and more than 400 certificates have been obtained.

The course of instruction given is as follows:—Monday, 6 p.m. to 8 p.m., workshop practice; 8 p.m. to 9 p.m., magnetism and electricity; 9 p.m. to 10 p.m., technical telegraphy. Wednesday, 6 p.m. to 7 p.m., magnetism and electricity; 7 p.m. to 8 p.m., technical telegraphy; 8 p.m. to 9 p.m., advanced electricity and laboratory practice. Friday, 6 p.m. to 8 p.m., workshop practice; 6 p.m. to 7 p.m., elementary laboratory practice; 7 p.m. to 8 p.m., advanced mathematics; 8 p.m. to 9 p.m., elementary mathematics.

We heartily congratulate Mr. Slingo on the success which he has attained.

THE SWINTON PATENT DIRECT INTERCOMMUNICATION TELEPHONIC SYSTEM.

THIS system provides a perfect means of putting all the apartments in a building in direct telephonic communication with one another, any one being able to call up and communicate direct with anyone else, without the necessity for the usual central exchange and its consequent attendant. One battery, located in any convenient place, suffices for any number of instruments.

For n telephones only $n + 2$ wires are required, and these can be made up into a cable of very small diameter. For n speaking tube stations perfect communication can only be obtained with $\frac{n(n-1)}{2}$ separate tubes. Thus, to establish direct intercommunication between, say, 12 stations, 14 wires, making a cable of about $\frac{1}{4}$ inch diameter, will do the work of 66 speaking tubes, occupying about 6 feet of wall space, and for larger numbers of stations the saving is still more marked.

At each station or room there is the ordinary complete telephone set and also a switch box fitted with plug holes, distinctively lettered or labelled with the names of the different telephone stations comprised in the system.

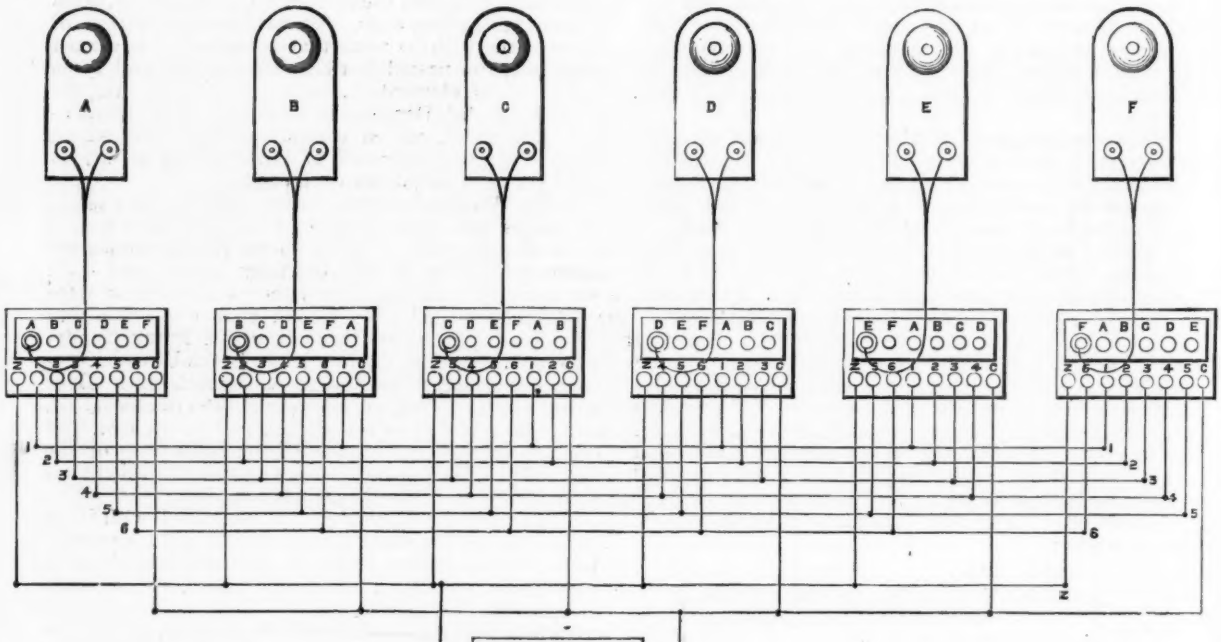
In connection with the terminals of the telephone is a flexible cord terminating in a small plug, which can be readily inserted in any one of the plug holes in the switch box.

The figure shows diagrammatically the telephone instruments, switch boxes, connections, and battery for an installation of six stations or rooms, A, B, C, D, E, F, distributed about a building.

It will be seen that the left-hand plug hole of each switch box is marked with the letter that denotes the individual station to which this switch box belongs. Z and C are the wires connecting the various switch boxes to the zinc and carbon terminals of the battery, and 1, 2, 3, 4, 5, 6 are the six line wires that are necessary to connect the various switch boxes together. The terminals of the boxes are numbered, and all bearing the same number are connected to the same wire.

When the telephones are not in use the receivers are all hung up on their respective switch hooks, and the plugs are inserted in the left-hand plug holes of the several switch boxes. Thus the plug belonging to A is inserted in the hole marked A, that belonging to B in hole B, and so on, as shown in the figure.

Supposing A wishes to communicate with C, he has only to remove his receiver from its hook, remove his plug from the hole marked A of his switch box, and insert it in the hole marked C, to cause the call bell at C to ring, the ringing of the bell being notified to A by a loud rattling noise in his telephone receiver, due to the current from the battery being rendered intermittent by the contact breaker of the bell at C.



On C removing his receiver from its hook the noise ceases, and A knows that he can talk to C and *vice versâ*.

When the conversation is completed, A replaces his plug in the A hole of his switch box, so that other stations may be able to call him up if required.

In a similar manner any one of A, B, C, D, E, F can call up and carry on a conversation with any other, and A and B can talk together while C and D are doing the same, or any other combination can be effected.

The system is so arranged that if, say, B tries to call up A or C while the latter are conversing with one another, the absence of the rattling noise in his receiver on his attempting to call attention intimates to B that the line is engaged. This prevents interruptions of conversation and any possibility of confusion.

The above examples show the principles of the system when applied to six stations, but, of course, the switch boxes can be made with any number of plug holes for a system comprising any number of stations; and when it is convenient that only some of the sta-

tions should have the power of calling up all the others, only these particular stations need have switch boxes containing the full number of plug holes, and be connected with the full complement of wires, the cost of the installation being thereby considerably reduced. Buildings have been fitted on this system with as many as six telephones, and a set of 27 is now being fitted up in the new warehouses in Leman Street of the Co-operative Wholesale Society.

NEW EXPERIMENTS ON THE ELECTIC ARC.

THE fact that the apparent resistance of the electric arc is very high and scarcely varies with its length has long been known, and has met with various explanations.

Edlund, and more recently Von Lang and Aron, writes Dr. E. Lecher in the "Repertorium der Physik," assume a counter electromotive force acting in opposition to the principal current, and thus producing the great difference in potential between the two electrodes. In like manner Frölich and Peukert, who, however, hesitate at the high figure of some 40 volts, and assume also a resistance of transition. On the contrary, G. Wiedemann, in his "Manual of Electricity," suggests that the arc is possibly a non-continuous discharge of electricity, a supposition which would also lead to an explanation of the facts observed. Lastly, I must mention a fourth point, which may possibly take a share—even if small—in the constancy of the potential difference, *i.e.*, the circumstance that the electricity expands spacially between the two points.

There are, consequently, four causes to be mentioned for the observed almost constant value of the potential difference, which may act either singly or possibly in combination :

1. Counter electromotive force.
2. Resistance of transition.
3. Non-continuous discharge.
4. Spacial expansion.

The phenomena of the arc are so complicated that in spite of numerous special experiments I cannot venture to pronounce decisively in favour of one or some of these hypothesis. The experiments seem, however, to render the suggestion of G. Wiedemann (non-continuous discharge) more probable, and the counter electromotive force of Edlund still more improbable.

We may conclude from the following simple experiment that on the extinction of the light the resistance rises only very gradually. If we introduce into a circuit which supplies an electric light the primary bobbin of a Ruhmkorff coil in such a manner that the light burns only where the interruption takes place in the interruptor in the ordinary use of the apparatus we do not obtain a spark in the secondary spiral on letting the carbons slowly burn out and expire, but only if we draw them rapidly asunder. In the former case the resistance increases too slowly. An investigation published by Edlund in 1867 (substituting corresponding resistances for the arc) proved that the potential difference may be expressed by the formula, $a + b\,l$, a and b being two constants, and l the length of the arc.

If $b\,l$ is considered as the ordinary potential difference corresponding to the resistance, the constant, a, can be represented not only by an electromotive force, but by the work which the current performs in the arc. The more recent experiments of Lang and Aron may also, I believe, be so interpreted that a certain quantity of energy is consumed in bridging over the interval between the two electrodes.

Is the Potential Difference of the Electrodes Dependent on Temperature?

Von Lang has determined the potential difference of various electrodes by means of a voltmeter (a galvanometer of a high resistance), and considers that this potential difference, or, as he expresses himself, the counter electromotive force, agrees with the melting-point of the material of the electrodes. But we also maintain that the metals may be heated in the arc almost up to their melting-point but never much beyond it, and that, therefore, the potential difference of the electrodes may be directly determined by their temperature. In this manner, the exceptional behaviour of silver is explained away.

I have found, in fact, that artificial changes of temperature may often effect considerable modifications in the potential difference.

The experiments carried out show, without exception, a dependence of the potential difference upon the temperature. It may be suggested that in various electrodes the potential difference does not directly depend so much on the substance of the electrodes as on the temperature, which in turn depends on the substance.

Some Experiments on the Interior of the Arc.

Experiments on the potential in the interior of the arc have not, to my knowledge, been hitherto undertaken. I will, therefore, communicate a few values which are perhaps not quite free from objections. I thrust into the arc a small carbon rod, 1½ mm. in thickness, placed vertically to the electrodes in such a manner that its end was exactly in the middle of the arc. The end of the rod became spontaneously pointed in the heat. The rod was connected with the electrometer and one electrode was connected to earth, so that the electrometer must take up directly the potential of the place of the carbon rod. It had been ascertained by preliminary experiments made with iron, platinum, and carbon, that the insertion of the rod did not perceptibly affect the potential difference of the electrodes.

With carbon electrodes there was found when the rod was in contact with the negative electrode, a potential of 46 volts which corresponds to the potential difference of the electrodes. If the point of the rod was not in contact with the positive electrode it could be moved along the entire arc without the potential varying greatly from 36 volts.

The one-sided potential difference observed with carbon does not occur with platinum, iron, silver or copper. The potential of the interior arc is approximately the mean between the potentials of the two electrodes. If a resistance to transition were in existence at the electrodes it would be found connected with certain phenomena which Guthrie has studied in connection with a different subject and which have recently been further investigated by other experimentalists.

As regards the appearance of the arc with various electrodes, I will communicate only one fact which is, I believe, important. If we screen the light radiating out from the electrodes for the sake of seeing the arc itself more distinctly, its breadth about the middle appears proportionally very great. Therefore the electricity does not pass straight from one electrode to the other, but passes in an expanding current. In any case, this spacial expansion of the arc must be taken into account in any explanation of its resistance, even if it should prove to be inconsiderable.

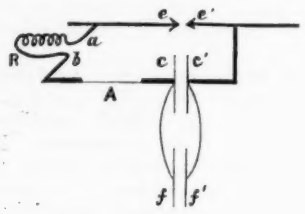
On the Non-continuity of the Arc.

The view, first propounded, I believe, by G. Wiedemann, that the transit of the electricity in the arc takes place in pulsations, has in it something very plausible, and a further insight into the circumstances of the case renders this suggestion more probable. But in any case, as a revolving mirror cannot revolve the arc into partial images, the single discharges must follow very rapidly upon each other. The experiments which I originally instituted did not render a discontinuity of the phenomenon manifest. Neither the dynamometer nor the telephone introduced in the

most varied manners, gave positive results. It is true that the application of the telephone may be easily deceptive, since in the current of a dynamo there occur tones of very high vibrations, explicable from the number of coils, the manner of wrapping, and the speed of rotation of this machine.

This source of error was eliminated by the use of a Bunsen battery, and the results of the experiments with carbon electrodes and a silent arc remained then always negative.

The following method is exceedingly sensitive, and gave to a certain extent a positive result. I made use of an apparatus constructed according to the indications of Hertz. A very thin brass wire, $\frac{1}{20}$ mm. in diameter, and of 50 cm. in length, was extended horizontally, the one end being fixed to a micrometer screw, whilst the other was connected with a copper spiral. Close to this end the brass wire was twisted once round a steel axle of 1·5 mm. in diameter. This steel axle, which rested above and below in well-finished brass bearings, supported a small mirror. If the horizontal brass wire was traversed by a feeble current, the wire became elongated by the heat, and the rotation of the mirror showed a corresponding deflection on a scale placed at the distance of five metres. Whilst the one electrode, e', as seen in the accompanying figure was in direct connection with one plate of a condenser, c', (one microfarad) there was introduced into the circuit which connected the electrode, e, with the other condenser-plate, c, the small apparatus, A, and the primary bobbin of a large Ruhmkorff apparatus, R, (resistance = 0·02); a b is a thick metal wire, which enables the Ruhmkorff to be quickly introduced into or removed from the circuit.



Let a b be closed by means of a metal in the first place; then, if the potential fluctuates rapidly at e and e', the condenser will be charged and discharged in quick succession, so that the streams traversing the thin brass wire must give a deflection.

Silver and copper electrodes give no deflection with any length of the arc.

Carbon electrodes give a deflection of some 40 mm., and more if the arc hisses; if the distance is greater, and the arc becomes silent, the deflection at once ceases. But if the arc suddenly begins to hiss, even at a greater distance, there appears at once a deflection. If alongside the first condenser, c c', I introduced a second one, f f', in a parallel position, the deflection was doubled. On introducing the Ruhmkorff (removal of a b), the deflection vanished at once. The potential fluctuations (as appears from the failure of other methods) follow upon each other so rapidly, that the self-induction of the coil, R, completely levels the several waves of the current.

With iron electrodes a deflection occurs even at a great distance, and if the electrodes are slowly approximated to each other the scale quickly passes beyond the field of vision. It is not generally possible to bring both iron points into contact in the arc, as the light previously goes out with a slight report. If the Ruhmkorff is introduced there ensues no deflection, nor is the light extinguished even if the iron points are brought into contact.

Still more striking are the experiments if platinum wires are used. The thin brass wire is heated so strongly that it generally melts at some point. I therefore connected the two electrodes directly by a thick wire with both condensers. At a distance of 3 mm. the arc burns very quietly, but if the two platinum electrodes are approximated, however gradually, the light goes out with a loud report when the electrodes are at the mutual distance of $1\frac{1}{2}$ mm., and it is impossible to ignite the two platinum electrodes by an arc. It is easily effected if the condensers are withdrawn, and also if the primary bobbin of a Ruhmkorff is introduced into the circuit leading to the condenser. If in the latter case the platinum electrodes burn very quietly at the distance of 1—2 mm. a simple removal of the Ruhmkorff (by bridging over a, b) is sufficient to extinguish the arc at once with a loud report.

From the above it seems to appear that at least in cases of iron or platinum electrodes the stream passes through the arc in pulses; on introducing the condenser it must be re-charged after each discharge, and it seems as if the rate of discharges was so much retarded that the arc expires. This action is probably intensified by the oscillations as they occur in the discharges of condensers.

A further application of this method enables us to decide which of the two poles plays the chief part in this discontinuous discharge. The following results appear.

In case of a hissing carbon it is the positive pole, for we can oppose to a positive carbon as the negative pole either another carbon or copper or silver when the results remain as before.

If we oppose to a positive electrode of platinum one of carbon, copper or silver, and bring both electrodes into short circuit with the condenser plates, the arc burns at distances of some millimetres almost exactly as at very small distances. The electrodes can even be brought into contact without the occurrence of anything remarkable. But if the direction of the current is reversed, *i.e.*, if in such and similar arrangements platinum is taken as the negative pole, the light expires suddenly with a report when the electrodes are slowly screwed together. It is impossible to ignite the arc at a distance of 1 mm. between the electrodes. The intercalation of the Ruhmkorff destroys this phenomenon, but a small spark indicates the occurrence of the inductive action in the secondary coil. Iron behaves like platinum, but less strikingly.

The phenomena described in this paper require above all things a quantitative investigation before we can have a firm foundation for a new hypothesis. The following conjectures may, however, be advanced as fairly probable. The transit of the electricity in the arc is discontinuous; in case of copper and silver the single beats follow so rapidly upon each other that they are incapable of actual demonstration. The number of the single beats with iron, and especially with platinum, is considerably smaller, and the phenomenon can here be shown by means of the arrangement employed. The discharges pass from the negative pole. A further conjecture why this intermittence is slower in case of the sparingly fusible or sparingly volatilisable metals seems premature. According to the experiments hitherto made, carbon, in spite of the high potential difference of carbon electrodes, seems as regards the discontinuity of light to stand nearer to silver and copper than to iron and platinum.

The definite results of this investigation are :—

1. A counter electromotive force has not yet been demonstrated by a return current.
2. The potential difference of the electrodes depends on their temperature.
3. If the negative electrode is iron or platinum the discharge is discontinuous.

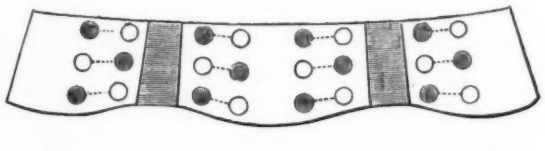
Execution by Electricity.—All efforts have failed to get Mr. Edison to join the competitors. "I am a humanitarian," the Menlo-Park inventor is reported to have said, "and a supporter of the abolition of capital punishment. Accordingly, rather than countenance your inventions, which I hold in detestation, I should be tempted to study the means of restoring to life, by electricity, the victim of capital punishment."

AN ELECTROPATHIC BELT.

IN our issue of December 23rd a correspondent who subscribed himself "A Poor Victim" drew our attention in pathetic and almost piteous accents to a little business transaction in which he considered himself more or less duped. Since that date a few letters have appeared in our columns touching upon the same matter, but it appears evident that the subject is one which does not appeal to the sympathies of electricians generally; and, indeed, the matter at issue is really one for the medical and the more respectable of the daily newspapers to ventilate rather than ourselves. Still, our correspondent having to an extent appealed to our editorial feelings and sent us the veritable article against which he so bitterly complains, we purpose offering a few comments upon the construction, action, and probable effects of the electropathic belt in question. The material from which it is manufactured is of the usual class, *i.e.*, elastic webbing, red flannel, calico, and what appears to be silk outside, the whole forming a very elegant and well made belt. On the under-side of this belt are discs, the size of half-crowns, of *tinned* copper and plain zinc, connected together as shown in the diagram, from which it will be seen that there are twelve separate galvanic elements, or, at all events, the electrodes therefor. These discs are secured through the material of which the belt is composed by eyelets, to all appearance of brass, and the appliance is fastened round the body by straps and buckles in the ordinary way. There are stringent rules to be observed by the patient, and it is earnestly enjoined that these are adhered to most strictly, as otherwise a completely satisfactory result cannot be relied upon. These directions for use are unique in their way, and are quite worthy of reproduction here:—

1. The appliance should not be worn at night-time unless specially directed.
2. They should be put on every morning, and worn throughout the day.
3. They should be worn with the galvanic discs next the skin, unless otherwise directed.
4. When a flannel or calico is supplied it should, when soiled, be removed from the discs, then washed, and replaced.
5. If any irritation to the skin is caused by contact with the galvanic discs, the appliance should be worn over the first garment for a day or two, and the irritation will rapidly die away.
6. No two persons should use the same appliance.

The last two of these mystic directions are admirable. The idea of employing an undervest as an insulator shows the medical electrician's belief in what may be termed faith healing, and the implied hint of the dire results of two persons trying, for economy's sake, to accommodate one another with the same belt, proves beyond a shadow of a doubt that the eminent one has a keen commercial instinct and knows well the value of £ s. d.



We will now proceed to enumerate the experiments which we have made with the three-guinea panacea. First of all we cut the wire connection between two of the discs and inserted in the circuit a very sensitive telephone receiver. On applying the discs to the body no sound whatever could be obtained in the receiver upon making and breaking contact, neither did the application of moisture to the body afford any better result. We therefore had recourse to a Post Office bridge galvanometer, a very fine and sensitive example of which happened to be at our command.

With the body dry no deflection was observed, but upon applying moisture a very slight motion of the needle was seen. Upon wetting the texture of the belt between two of the discs with a weak solution of sal-ammoniac, a feeble galvanic couple was set up, and the needle of the galvanometer was sluggishly deflected some degrees; and upon substituting the telephone for the galvanometer, faint ticks were heard upon making and breaking contact. These effects, of course, were foreseen; but to what do they amount after all? For it must be borne in mind that to get at these results, we had to disturb the highly scientific arrangement which we will now discuss. We have a belt in which 12 separate galvanic elements are formed if the material is moist, but the current from these small local batteries cannot possibly have any material effect upon the human system for several reasons. We may look upon a pair of discs, and the material upon which they are secured, as the interior of a galvanic cell, and a profuse perspiration from the skin sufficient to well moisten the material of the belt, as the electrolyte; the short piece of wire which connects the two metals completes the circuit. The only use that portion of the skin confined within the limits of the two metal circles can possibly have, is to supply an electrolyte in the form of perspiration to the interior of the cell which is the flannel or calico of the belt. We have then a feeble galvanic element, the difference of potential being that between tin and zinc, of high internal resistance, *absolutely short-circuited* by the short length of wire connecting the outer surfaces of the discs, and consequently with its feeble electromotive force rendered still less by polarisation. Both metals are secured in their places by brass eyelets, which we need scarcely say offer a fair field for local action, and the precipitation of zinc salt upon the skin would not we imagine be to the benefit of the unfortunate victim whose credulity led him to adopt an electropathic belt of this kind as part of his attire.

Even supposing that means had been provided for generating electric currents in the belt itself, so that the body might form the exterior circuit, or even of making the belt simply the medium for applying current from properly constructed galvanic batteries, the distribution of the metal discs is so arranged that only that portion of the cuticle between them could possibly be affected. The result would be a series of 12 local circuits around the body, and what benefit can be anticipated from such an application of electricity it puzzles us to see.

The true state of the case is simply this:—The "eminent medical electrician" has just reversed the order of things; any competent practitioner would employ a battery, specially constructed for medical purposes, and apply the electrical energy in such a manner that the body, or portions of the body, completed the external part of the galvanic circuit, whereas the originator of the marvellous electropathic belt under discussion makes use of the secretions of the skin to moisten the material between any pair of discs, the feeble galvanic couple thus set up being actually short circuited externally. In other words, the human body instead of being the recipient of electrical energy, is made the means of generating it for no earthly good whatever. The whole thing would be a subject for nothing more than ridicule were it not for the fact that the trade in these so-called curative appliances has assumed proportions which call for protest in no measured terms. But as we have previously said, our efforts will not avail the public one jot unless we are supported by the entire medical and the respectable daily press. Only by these means can our exposure of such absolutely worthless contrivances be brought before the notice of those who are beguiled by cunningly worded and seemingly truthful advertisements to part with large sums of money for articles which are sold at 20 times their real money value.

We do not ignore the fact that many silly, imaginative, and deluded individuals are always ready to assert, upon oath if necessary, that after adopting electropathic belts, magnetic chest protectors, and such like appliances, they have received incalculable benefit, and this assertion may in some cases be actually true, but that their relief is due to any electric or magnetic agency we utterly deny. The fact is, that to many people a belt or chest protector is absolutely necessary if they desire freedom from many of the little ailments

more or less worrying and troublesome, to which most of us are subject; but such articles, stripped of all such fictitious aids to recovery as metal discs or feeble magnets of crinoline steel, are equally efficacious and can be obtained for a twentieth part of the cost.

We commend these remarks to our medical contemporaries in the hope that they will take up the matter where we stay our hands, and try with all their might to stamp out a most pernicious form of unprofessional trading, and one which affects in a considerable degree that important and indispensable body of professional men which they so ably represent. The proposed Institute of Medical Electricity might with advantage begin its career with a determined effort to drive all quacks and charlatans out of the field, and then a properly formed channel could be developed for electricity, when intelligently and scientifically directed, to assert its manifold virtues as a curative agent for many of our maladies.

If what we have said should prove the means of saving only a few of the many thousands who are annually duped by the abuse of the mystic nature of electricity, we shall not have penned this article in vain.

REVIEWS.

A Course of Lectures on Electricity, delivered before the Society of Arts by GEORGE FORBES, F.R.S., &c. London: Longmans, Green & Co.

These lectures, which were delivered in 1886, were five in number, and were given under the following heads:—"Potential and Electromotive Force," "Electric Current," "Magnetism," "Electro-Magnetism," "Electro-magnetic Induction." A sixth lecture on Dynamo-Electric Machinery, delivered before the Franklin Institute, America, in 1884, is added. Although the general run of experiments followed in the course of the lectures is much the same as is usually met with, yet the lectures bear a distinct impress of modern thought and to a great extent also of originality. Speaking of the ordinary rule which states that "like electricities repel, unlike attract," the author remarks "this is a most unscientific way of speaking, because there are no such things as electricities. Electricity is merely the science of electrical phenomena. Nor is it ever true that the electrified bodies attract and repel each other. It is the electrified space which acts on the electrified bodies and makes them act as if they attract and repel each other." Referring to the Wimshurst machine, it is stated that the expenditure of energy to produce light (by means of the spark) is probably less than with any known system of illumination, though, as shown, it cannot be applied in practice. Taking the book generally, there is nothing very special in it which calls for remark; but we think that it fairly brings into a popular lecture form much modern matter which has hitherto not been put into shape; the author is right in saying that in the science of electricity there has been a vacant space, and he has certainly gone far towards filling it.

Formulaire Pratique de L'Electricien, par E. HOSPITALIER. Sixième Année, 1888. Paris: G. Masson, 120, Boulevard Saint-Germain.

In this latest edition of this well-known work the most recent progress of electric science and of its industrial applications has been taken note of. We observe with pleasure the care which is taken each successive year to increase the utility of the book.

Journal of the Society of Telegraph-Engineers and Electricians. No. 68. Vol. XVI. E. and F. N. Spon, 125, Strand, London.

This issue of the Society's Journal contains the papers read by Mr. Stallibrass on "Deep Sea Sounding in connection with Submarine Telegraphy;" Prof. Fleming and Mr. C. H. Gimingham on "Some Instruments for the Measurement of Electromotive Force and Electrical Power;" Profs. W. E. Ayrton and J. Perry on "Portable Voltmeters for Measuring Alternating Potential Differences." An original communication by Mr. A. E. Kennelly on "The Superiority of the Earth-Overlap;" "Method of Localising Small Faults in Submarine Cables when no Loop is available," is also given. The usual Abstracts completes the number.

We have also received "The Institute of Actuaries' Text Book of the Principles of Interest, Life Annuities, and Assurances, and their practical application," Part II., by GEORGE KING, Actuary of the Atlas Assurance Company. To those who are interested in the subject the book will prove of great value. The publishers are C. and E. Layton, 56, Farringdon Street.

ELECTRIC LIGHTING AT BOURNEMOUTH.

WITH regard to the proposed adoption of electricity for public lighting at Bournemouth, the surveyor (Mr. G. R. Andrews) has prepared an exhaustive report, in the course of which he states that there is at the refuse destructor spare energy equal to 30 H.P., available night and day, which could be used during the daytime in charging four batteries of accumulators in series, each battery to be capable of supplying fifty 16-C.P. incandescent lamps for a period of nine hours after full charge. These batteries could be arranged for the supply of one installation of 200 lights each, the batteries being placed in suitable positions. It would not be practicable, on the ground of economy, to deliver the current from accumulators placed in the engine room at a distance of a mile and a quarter, but there would be no difficulty in obtaining suitable positions for these at the required points of supply, as the space occupied at the cells would be but small. Ample time could be found during the day for charging these accumulators from suitable dynamos in the engine rooms, and at a convenient time the charging current could be stopped and the power then be applied to driving an arc light machine, which could supply 25 arc lights, situated on the pier and any other positions, as required. By this arrangement there would be at all times a supply from the accumulators for 200 incandescent lamps of 16 C.P., and the plant would afterwards be available for the maintenance of 25 arc lamps of 1,000 C.P. There would be engine power from the gas engines in the pleasure grounds sufficient for 32 arc lamps of 1,000 C.P., or sufficient for 320 incandescent lamps of 16 C.P. each. By this scheme there would be provided 57 arc lamps of 1,000 C.P. each or 520 incandescent lamps of 16 C.P. each. He found upon inquiry in London, where the electric light was in successful use, that the arc lamps of 1,000 C.P. each could be supplied at one penny per lamp per hour. The incandescent lamps of 16 C.P. each could be supplied at a farthing per lamp per hour. In looking over the annual statement of accounts, he found there were 773 public lamps in use, including the fifteen large ones, at a total cost of £1,986 13s. 7d. The present cost of gaslight of 15¼ C.P. taken from the above was about 1¼d. per lamp per hour, equal to 5·09 cubic feet per hour. An appropriate estimate of the cost of electrical plant, cables, &c., was as follows:—Shunt wound dynamos, series-wound dynamos for arc lighting, charging leads from engine houses to accumulators of best lead sheathed cables, leads to arc lamps, suitable wooden troughing for carrying the cables underground for the distance of 1½ miles, batteries of 53 E.P.S. cells in glass boxes with suitable wooden stands, trays, and insulators complete, all necessary electrical apparatus for each installation of 50 16-C.P. incandescent lights, including switchboard, cable, and casing, lamps and holders, "on and off" switches, secondary generators or transformers, fusible cut-out ammeter, cell-testing voltmeter, &c., 25 arc lights, resistance for arc lighting circuits, shafting in engine rooms, engine, boiler, storage, foundations, excavations, carriage and labour £6,175. He found that the Local Government Board would give their sanction for loans for lamps for public lighting to extend from 10 to 20 years. Therefore, to borrow the sum of, say £6,000 for 20 years at 4 per cent., the interest and repayment of loan would be £441 10s. per annum. After inspecting the successful method of electric lighting in London, he was of opinion that the only systems which are equivalent in their reliability to the supply of gas, are the automatic storage supply from storage batteries or the alternating current transformer system, which does not depend in any way on the good working of any moving machinery. There are two ways of carrying this scheme into effect:—First, by obtaining the permission of the Local Government Board to borrow the money; and secondly, by obtaining estimates from electrical engineers by entering into an agreement for the same. The above report is being considered by a committee of the Bournemouth Commissioners.

NOTES.

Electric Light in the Royal Navy. — There was a brilliant display of the electric light on board H.M.S. *Vernon*, torpedo school ship at Portsmouth, last Friday night on the occasion of a grand ball given to about 500 guests by Captain Long and the officers of the ship. Visitors were disembarked from the various steam launches at the entry port of the orlop deck, where clusters of incandescent lamps were suspended from the davits. The passage to the ball room was illuminated by electric bull's eyes, divers' head dresses flashing rays of light from the eyes, and innumerable ship's lanterns. In the refreshment room there were two incandescent lamps of 500 C.P. each, besides many lesser lights, and tiny coloured globules also emitting electric rays were clustered round a charming fountain. The ball room, where there was a choice exhibition of old armour and antiquated weapons, was also beautifully lighted by electricity.

Electric Lighting at Portsmouth. — Hitherto no serious attempt has been made to introduce the electric light into anything like general use in the large and rapidly growing Borough of Portsmouth. Some time ago a representative from one of the large companies was sent to Portsmouth to canvass the principal tradesmen, but although he received several promises of support these were not sufficiently numerous to justify the starting of a central station. A local company is, however, now on the *tapis*, it being considered that there is a good opportunity for pushing a successful electrical business, although it is only recently that the Gas Company, which is a most flourishing concern, reduced its charges.

Regulations for Electric Lighting. — The Vienna Society of Electricians some time ago appointed a committee to draw up rules and regulations for the public supply of electricity, which will be submitted to Parliament with a view to obtaining a kind of Electric Lighting Act for Austria. The committee, says *Industries*' correspondent, has finished its labours, and its report will be laid before the members at the next general meeting of the society. It will then be discussed, and, if necessary, amended, after which the society will finally adopt and recommend it as the basis of a Bill to be introduced in the next session of Parliament.

Search Lights.—Messrs. Czeija and Nissl, of Vienna, have just brought out a new search light, which has been specially designed for use on torpedo boats. The lamp is self-feeding and works perfectly well, not only when placed vertically, but even when inclined to an angle of 65° from the vertical.

Electric Lighting in Vienna. — The Allgemeine Elektricitats Gesellschaft, of Berlin, is now establishing a branch in Vienna. The company has commenced negotiations with the Imperial Continental Gas Association, with a view to taking over the electric light works in the Schenkenstrasse, and the installation at the Vienna Opera House. At the forthcoming exhibition in the Prater, generally speaking the electric light will be installed, not as an exhibit, but with a view to produce the best illumination of the other exhibits. The total motive power required is estimated at 600 H.P.

Lighting of the National Concert Hall.—The large building which a company is being formed to erect near the Victoria stations as a concert hall is to be lighted throughout by the electric light.

Herne Bay and the Electric Light.—At last week's meeting of the Herne Bay Local Board, the clerk was requested to communicate with the manager of the Electric Lighting Company with a view to the adoption of a fresh scheme for the illumination of the Tower Gardens.

Electric Lighting of Oldham Art Gallery.—At the last meeting of the Oldham Gasworks Committee the Mayor reported respecting the inquiries he and Alderman Buckley had made since the last meeting as to electric lighting. He stated that they had arranged with Messrs. Charlesworth, Richmond Hill Ironworks, Oldham, to put in the requisite apparatus to light the upper storey of the Free Library for the forthcoming exhibition of pictures, which would be opened on the 1st February. The contract included the lighting and fixings, which will be permanent, and the dynamo, which would be hired at a cost of £7 per month. As to the engine power, Mr. Buckley had found they had there already working an engine in the mechanics' shop which would be sufficient for the purpose. They would have the whole ready and in working order for the 1st February, or perhaps a day previous to that date. The committee approved of the action taken.

Electric Lighting at Taunton.—The Taunton Electric Lighting Company has been in existence for rather more than a year, and has earned a dividend of 5 per cent. on the subscribed capital, placing a sum of about £100 to the depreciation and reserve account. The experiment having thus far been successful, an extension is called for. There are several demands for "more light" from tradesmen and business firms, but these cannot be complied with without an increase of plant, and that necessitates the taking up of more shares. The Mayor, who has taken up the matter with characteristic energy, has put his name down for a considerable amount, and other gentlemen are following suit. The additional capital required is about £2,500, and of that amount £750 was subscribed at a private meeting held on Wednesday evening last week.

Electric Light on the North British Railway.—A "Traveller" writes to the Glasgow *Evening News* as follows: "As an every day traveller between Alexandria and Queen Street, I have reason to complain about the lighting of the carriages in the tunnel. Truly, the N.B.R. have fitted up the electric appliances in their carriages, but it must be only for an ornament. The two globes are there for the light, but where is the light itself? One morning in the week it shines up, but during the rest it takes a sleep."

Re Electric Light in Cheltenham. — Messrs. Page and Son, of High Street, Cheltenham, found the electric light so beneficial during the Christmas show week, in the avoidance of both heat and dirt, that they have decided on permanently using it, and for this purpose alterations for the accommodation of storage cells are now being carried out.

Prize for Electric Light Installation.—Among the subjects for which the Société Industrielle of Amiens has offered a prize, is "the best electric light installation in an industrial works." The light must have been in operation for at least a year, and it must be proved to be cheaper than gas made on the premises. Further, the installation must be equivalent to a gas system of not fewer than three hundred jets. Detailed plans and descriptions must be sent in before the 30th April next.

Temporary Electric Lighting.—Tranby Croft, Yorkshire, the residence of Mr. Arthur Wilson, whom Prince Albert Victor was last week visiting, was lighted by means of incandescent lamps, in globes of various colours, on the occasion of a ball at which the Prince was present. The installation was carried out under the superintendence of Mr. Thos. Muse, of Hull.

Philadelphia City Hall Lighting.—It is a significant fact that the commissioners of public buildings in Philadelphia have refused to accept tenders from electric light companies for the illumination of the City Hall. It is naively remarked that the commissioners are desirous of securing the best system and the employment of capable men. We understand that from 12,000 to 13,000 lights will be required.

Electric Lighting in the City.—When Mr. Pannell at the last meeting of the Sewers Commission opposed the acceptance of the contract which the Streets' Committee were about to enter into with the Brush Company, it was asserted very generally that no company would consent to the terms which he insisted upon. The amendment he proposed was, however, accepted, and we are now informed, on exceptionally good authority, that the Brush Company on Friday agreed to deposit the sum of £1,000 to be absolutely forfeited if the contract for lighting the streets by electricity were not begun by April next, and concluded before October, 1889. The company also agreed to give up their claim to a monopoly for supplying fittings, &c., to private consumers.

At the meeting of the City Commissioners of Sewers, the Streets Committee had on the paper of business a report submitting for adoption an amended arrangement with the Anglo-American Brush Electric Light Corporation for lighting a district of the City by means of electricity. Mr. J. C. Bell (the chairman) said, seeing the lateness of the hour and the paucity of the attendance, it would be better, perhaps, to postpone the consideration of the report. Mr. Bridgman thought as the Court had agreed to the report in substance, they might as well go on with it. Mr. Shaw urged the Court not to do so, and on the suggestion of Mr. Deputy Ashby, it was resolved that the remainder of the clauses should be printed and their consideration adjourned. The Remembrancer (Mr. Goldney) subsequently made a statement respecting an application of the South Metropolitan Electric Supply Company for a provisional order to light a large part of the eastern and western ends of the City. A part of the area would be from Chancery Lane, along Fleet Street, down New Bridge Street, and along the Embankment, a portion of the district which he understood the Commission had before them with reference to the Brush Company. The provisional order, if obtained, might be afterwards confirmed by Parliament. It would give the supplying company a monopoly of that ground, and if the commissioners determined to give the lighting to the Brush Company they must oppose it. It would be hardly possible for the two companies to occupy the same ground. Mr. Deputy Ashby thought they ought to let the companies do as they like. Mr. J. C. Bell was surprised that the deputy should object to the commissioners giving themselves a *locus standi*. While they were on the brink of coming to a conclusion another company was to have a monopoly and shut them out. This company wanted to put innumerable wires overhead. He moved that instructions be given to oppose the Bill, which was agreed to.

Electric Lighting at Smith and Sons'.—Messrs. Woodhouse and Rawson, Limited, have been entrusted with the wiring of Messrs W. H. Smith and Sons' extensive premises in the Strand, in connection with an installation of the electric light.

The Electric Light in Abyssinia.—The Italian army has introduced the electric light into Abyssinia, Fort Victor Emmanuel being lit by its means.

The Lighting at the Garth, Bicester.—The electric lighting of the residence of Mr. Brocklehurst at Bicester, to which we referred last week, was effected from a number of Volta Pavia cells supplied by Messrs. Loeb and Co.

The Fire at the Grand Theatre.—Mr. J. Sheppard, the surveyor of the North British and Mercantile Insurance Company, thinks the fire at the Grand Theatre may have been caused by a spark from the gas, scenic fires or explosions, represented in the pantomime, floating up and lodging on the gridiron, or that a spark might have been drawn through the ventilator from one of the chimneys of the model dwellings near, which were about the height of the stage ventilator.

The Telephone as a Fire Alarm.—We learn that Kansas City, with a population of over 100,000, depends exclusively on the telephone for fire alarms. It is stated that the service is most efficient, and affords the greatest satisfaction.

Launch of a Cable Steamer.—Last week. Messrs Robert Napier and Sons successfully launched from their shipbuilding yard at Govan a steel screw telegraph cable steamer of 1,050 tons for the Eastern Telegraph Company. The vessel has been specially designed by Mr. Joseph Birnie, London, for laying and repairing the company's submarine cables; and while externally she has the appearance of a Trinity yacht, internally the arrangements are of the most complete description for the difficult work she is intended to perform. Besides the usual appliances of a first-class modern steamer the vessel is fitted with large circular tanks for holding the telegraph cables, and has been sub-divided into numerous water-tight compartments for trimming and ballasting purposes. Her dimension are as follows:—Length, 210 feet; breadth, 31 feet; and depth, 24 feet. She is classed A1 at Lloyd's under special survey. Very complete and comfortable accommodation has been provided for the officers, electricians, and crew, and the chart-house and testing-room will be fitted with the best instruments for the work of laying and repairing cables. As the vessel left the ways she was named the *Amber* by Miss Agnes M. Hamilton. After the launch the visitors were entertained to a cake and wine luncheon in the offices, during the consumption of which it was stated that the *Amber* was the finest vessel of the Eastern Telegraph Company's fleet of five cable steamers.

The Westinghouse Alternating System.—"An Observer," writing to the New York *Electrical Engineer*, says: "All the explanations heretofore published of the Westinghouse dynamo have been deceiving as to the number of reversals the machine gives, and I see that Mr. Addenbrooke, in an article in your paper for December,* has gotten a false impression when he comments on the number of reversals being unnecessarily high. The 650 and 1,300 light machines have a speed of 1,650 revolutions, but they have only 10 field magnets instead of 16, as I have seen it stated in a number of electrical papers. This would give 16,500 alternative or 33,000 reversals per minute, instead of 40,800, as Mr. Addenbrooke is led to believe."

Edison's New Laboratory.—Edison's new laboratory, now in course of erection at Orange, New Jersey, will comprise a main building 275 ft. long by 57 ft. broad, surrounded by four smaller structures each 110 ft. by 17 ft. The central building is to be three stories high, the ground floor containing heavy machine tools, whilst the second will be fitted up as a photographic studio and drawing office, and the third will be supplied with the apparatus necessary for experiments in electricity. Power will be supplied from two steam engines and four dynamos. Of the minor buildings, one will be almost exclusively reserved for magnetic experiments, and iron will, therefore, not be used in any part of the building, its place being supplied by copper, brass, and lead. The other buildings will contain chemical and metallurgical laboratories, and a carpenter's workshop.

Fatal Gas Explosion.—A terrific gas explosion occurred in the Four Courts at Dublin last week, resulting in the death of a lad named Mulally, who was assisting a gas fitter to repair a leaky pipe.

The Associated Chambers of Commerce.—The 28th annual meeting of this association, to be held at the Hotel Metropole on February 21st, 22nd and 23rd, will be a busy one, even if half of the questions upon the programme are discussed. There is the usual array of resolutions upon educational, Post Office, telephone, railway, shipping, and other matters.

* Reproduced from the ELECTRICAL REVIEW.

Proposed Electric Railway at Portsmouth.—The promoters of the proposed Electric Lighting Company in Portsmouth have also in view the establishment of an electrical railway on the Southsea Esplanade between the Southsea Clarence and South Parade Piers, a distance of about a mile. As the metals would have to be laid in the carriage road it would, of course, be necessary to obtain the permission of the Corporation, and it is exceedingly doubtful whether such would be given. The projected railway would doubtless prove a most powerful attraction to visitors and a good paying concern to the shareholders, but the whole idea is at present *in nubibus*, and is scarcely likely to be realised owing to the difficulties which must be encountered in dealing with the local authorities.

The School of Electrical Engineering, Hanover Square.—The present year being the twentieth since this well-known school was first opened, the managers have issued a new prospectus of the same. The rapid progress which electrical engineering has been making has somewhat thrown in the shade the telegraphic branch of it; this change has been fully recognised in the school, and while the branch referred to has by no means been neglected, yet the course of instruction is such as to fully meet the requirements which the new condition of affairs has brought about. The general contents of the prospectus are as follows:—Frontispiece, the principal workroom; electrical engineering as a profession, and how to prepare for it; advantages of the profession; special features of the school; terms for non-resident pupils; arrangements for boarding pupils; extracts from a few recent testimonials; the training of electrical engineers; view of the engine room and workshop; press notices of a *conversazione*; foreign pupils; view of the machine room, &c.; outline of the course of instruction; a few recent press notices; references to older press notices; an old pupil's work in Maderia; electric lighting at a profit.

The Royal Institution.—Lord Rayleigh, the newly-appointed Professor of National Philosophy, in the place of Professor Tyndall, commenced his first course of lectures on Saturday afternoon. The title of the course is "Experimental Optics," and the lectures are illustrated by the electric light.

Electrical Execution.—A Commission appointed by the State of New York to discover a mode of executing criminals more humane than hanging has just concluded its inquiries, and has pronounced unanimously in favour of inflicting the punishment of death by means of electricity.

Compound Winding.—On Saturday, the 21st inst., Messrs. King, Brown and Company, of Edinburgh, served upon the Anglo-American Brush Electric Light Corporation, Limited, which carries on business at No. 6, York Place, Edinburgh, a summons to appear in the Scotch Courts, in which interdict and damages are asked under Clause 32 of the Patent Act. It is alleged that the Brush Electric Light Corporation has threatened Messrs. King, Brown and Company with proceedings for two and a half years, and although challenged to bring an action, has failed to do so. Possibly this action will involve a discussion of the validity of the Brush Corporation's patent for compound-winding.

The Academie des Sciences.—The Academie des Sciences' subject for the Grand Prix des Science Mathematiques, is still "The perfecting in some important point the theory of the application of electricity to the transmission of power." The prize will consist of a medal of 3,000 francs value. The papers have to be sent in to the Secretary before June 1st. The Academie during its sitting of November 14th, 1887, decided to found a gold medal embossed with the effigy of Arago. This medal will be awarded by the Academie each time that a discovery has been made or work done in the service of science which is considered worthy of notice.

Conversazione.—At a *conversazione* and concert of an interesting character, held at the Edison and Swan Company's Works, Ponder's End, nearly the whole of the *employés* accepted the invitation of the manager, Mr. Gimingham, to whose kindness the entertainment was due. A pleasing programme was provided, and the performances were much appreciated, encores being frequent. Mrs. Gimingham, and one or two of the young ladies in the factory, played the accompaniments. Coloured incandescent lamps illuminated the large room in which the gathering took place. Light refreshments were bountifully provided, and the entire arrangements were carried out in a highly satisfactory manner.

Dangers of Overhead Electric Wires.—One of the telephone wires crossing Fourth Avenue at Fourteenth Street, New York, recently broke and fell upon an electric light wire. A luckless horse underneath became entangled in the broken end of the wire and dropped to the pavement as though it had been shot. The driver jumped from his car and was about to tear the wire from his horse's neck, but was held back by a policeman. It was then discovered that the horse which had fallen was dead. Travel was delayed on the Fourth Avenue line for over a half hour. Finally, a man came along with a ladder, and with a huge pair of rubber gloves on his hands. He climbed the ladder, which the policemen held, and cut the wires. The circuit was thus broken and the danger removed. The horse was quickly hauled from the track and travel resumed.

Communications with Lightships.—Replying to representations from the Dover Town Council yesterday (Thursday), with reference to communication with lightships, the Board of Trade state that experiments are to be made over a period of 18 months with an electric cable between one of the Goodwin Sands lightships and the shore. If then the experiments are found to be successful, cables will be laid between the shore and lightships in dangerous positions.

A Paisley Electrician in Canada.—A Paisley gentleman writes from Montreal to a local paper commenting upon the success of Matthew Hutchison, nephew to Mr. Robert Hutchison, 83, High Street. Young Hutchison left Paisley in May: his certficate from the Andersonian College was forwarded to him in September. That certificate, combined with the satisfaction he has given to his employers by good work and steady and industrious habits, have been instrumental in securing for him an appointment which places him in charge of the electric station, Vancouver, British Columbia, for which distant city he left on December 6th by the Canadian Pacific Railroad, with the most sincere good wishes of his employers, fellow-workmen, and other friends for his prosperity.

Inexperienced Telegraph Operators.—The growing practice of employing inexperienced and uneducated youths as operators on telegraph circuits is severely criticised by the New York *Electrical Engineer*. The speed of transmission has increased by improvements in instruments, the cost to the public of telegraphy is decreased, and the working expenses have been reduced, but the quality of the service is rapidly deteriorating. Not only have errors of transmission augmented in number, but absolute secrecy as to the intelligence conveyed from office to office is no longer to be depended upon. These defects are the results of the employment of underpaid and inefficient labour.

The Electric Arc.—The experiments of Dr. E. Lecher on the electric arc might be followed up with advantage by experimentalists in this country. Perhaps Mr. Swinburne or Captain Cardew will some day undertake such an investigation.

Lineff's Electric Car System.—A car fitted according to the system devised by Mr. Lineff was tested on Tuesday afternoon at the depôt of the West Metropolitan Tramway Company at Chiswick. Mr. Lineff's invention consists in the method of conveying the current to the tramcar. The current was generated by means of a stationary engine and dynamo placed in an engine house at the depôt, in the yard of which an experimental line nearly a quarter of a mile in length has been laid down. An Immisch series-wound dynamo was used, and the current was conveyed along the line by a copper insulated wire conductor, carried in a channel running centrally to and parallel with the rails. At intervals on the conductor small saddle-shaped rubbers were mounted, and from the underside of the tramcar a wire was suspended between two vertical arms which entered and ran in a groove formed in the upper part of the channel. The wire was of sufficient length to touch several of the saddles at the same time, and by this means the current was transmitted from the conductor to an Immisch series-wound motor placed under the floor of the car. Motion was transmitted to the wheels of the car through gearing, and the car was started and stopped by switching the current on or off by a very simple apparatus operated by a small handle in front of a dial. On this dial were marked the necessary indications for guiding the driver as to the point at which the handle should be placed to effect any given purpose. The car was completely under the driver's control, and when running at a fair speed could be stopped within its own length by means of an electrical brake. There is an arrangement whereby the brake is made self-acting. A hinged guard board is placed at each end of the tramcar just clear of the road. Directly the board comes in contact with any object on the line the car is stopped and reversed. A number of runs were made with the Lineff car, both loaded with passengers and empty. It has been estimated, we learn, that the adoption of this system by the West Metropolitan Tramway Company would effect a saving of about 50 per cent. upon the present cost for horse traction, and it is stated that arrangements are being made for trying it on the line from Hammersmith to Kew.

Underground Wires.—The committee appointed by the Boston Common Council to investigate the question of underground wires, states in its report that it is an admitted fact that all wires must be eventually placed underground, the only point at all doubtful being the method which should be adopted. Two systems are quoted as being excellent—those employed at New York and Philadelphia. The committee came to the conclusion that the New York system was most suitable for Boston, owing to the conditions obtaining as regards the streets. The report pointed out that it would be hardly wise to compel each individual company to build a separate conduit or subway, and it was suggested that the city should construct a subway or conduit capable of carrying all the surface wires now in operation. It is to be remarked that no mention was made as to the insulation of the conductors. But in this respect the Boston committee is not singular, the question of the mechanical and electrical protection of wires being as a rule, that is to say so far as we have noticed, treated either as a secondary consideration, or as a Gordian knot impossible to unravel.

Terrible Fall of a Lineman.—At Bolton a day or so ago a telegraphic lineman, named Edward Isherwood, who was repairing insulators, fell from one of the poles in the centre of the town, a distance of over 40 feet, and, rebounding off the roof of a hostelry, fell upon the stone pavement, receiving such terrible injuries that he is not expected to recover.

Telephonic Researches.—The researches of Mr. C. J. Kintner on the transmission of speech by interrupted electric currents are very interesting, and doubtless his allusions to the Reis apparatus will appeal forcibly to the sympathies of Prof. Silvanus P. Thompson.

New Postmaster of Manchester.—Mr. R. W. Johnston, now Postmaster of the Western District Office, London, has been appointed Postmaster of Manchester, in succession to the late Mr. Beaufort. Mr. Johnston entered the Post Office service in December, 1861, having previously been six years in the service of the Electric and International Telegraph Company. In 1870, on the acquisition of the telegraphs by the State, he was appointed Controller of the Special Arrangements Branch. His later record is as follows: In 1878 appointed Postmaster of the East Central District Office. In 1882 appointed Postmaster of North Western District Office. In 1887 appointed Postmaster of the Western District Office. Mr. Johnston's experience has been wholly metropolitan.

Exhibition Awards.—Messrs. Woodhouse & Rawson, Limited, have been awarded a gold medal at the Saltaire, and a bronze medal at the Newcastle Exhibitions.

Price of Copper Wire.—Consequent in the fall in the price of copper generally, that for high conductivity copper wire was reduced at the beginning of the week ¾d. per lb., making the basis price 0 to 20 11½d. per lb.

Lecture.—On Thursday Mr. Edward Carter lectured on "Electricity," in connection with the Liverpool Science Club Free Lectures.

The Ball Dynamo.—Readers of the REVIEW will doubtless recollect our description of this so-called unipolar machine, and also the published tests made by the late Robert Sabine and those afterwards by ourselves. A contemporary recently made the following comment respecting it:—"Of course, we all know that this machine never could, and never would, work according to any recognised theoretical assumptions." Prof. Anthony, late of Cornell University, has written a letter in reply to the above criticism, in which he shows that the Ball machine not only can, but *does* work exactly as theory would indicate. We agree with the Professor that there is nothing strange or unaccountable about it, although it has been the subject of much ridicule, the result, doubtless, of misunderstanding.

Babcock and Wilcox Boilers.—With reference to the new boilers ordered to replace the faulty ones at the Vienna Opera House, we are informed that the first lot shipped by Messrs. Babcock and Wilcox are now complete, and have been accepted and passed by the Government inspectors, and will at once be put to regular steaming use.

Liverpool Exhibition Plant.—We understand that the engines, machinery and plant employed for the electric lighting of the late exhibition at Liverpool will shortly be dispersed by auction by Messrs. Wheatley Kirk, Price & Goulty.

Legal.—In the action Smart, Black & Co. *v.* United Telephone Company, in which judgment was some months ago given in favour of the plaintiffs, the defendants on Wednesday moved in the Queen's Bench for a new trial. The action was brought by a firm of importers of Swiss embroidery and haberdashery, carrying on business in the City, to recover compensation for injury to their stock, caused, as they alleged, through the fall of a telephone wire belonging to the defendants, which was stretched across the roof of their warehouse, and which fell during the great snowstorm of Christmas, 1886. It was alleged that the wire in falling swept the snow off a portion of the roof, and caused a gutter to give way, in consequence of which, when the thaw came during the Christmas holidays, snow-water entered the plaintiffs' premises and damaged their stock. On the other hand, defendants contended that the falling of the wire had nothing to do with the breaking of the gutter, which was due to the weight of the snow. Their lordships refused a new trial.

Electric Lighting in Venice.—Three distinct electric light installations have been started at Venice. One of these has been fitted up on the seaside promenade, Lido, a small island in front of the harbour, by the Edison Company of Milan, and consists of over 20 Siemens arc lamps and 200 incandescent lamps. There are two 30-unit Edison dynamos, and motive power is provided by an engine made by Messrs. Ruston, Proctor & Co., of Lincoln. The second installation is in the public gardens, and has been carried out by a local electrician on behalf of the Elektrotechnische-Fabrik, Cannstadt, Germany. There are 28 arc lamps taking 6 ampères each, and 200 glow lamps, current being supplied by two 12-unit dynamos made by the above firm. The engine is by Messrs. Sulzer Brothers, of Winterthur. The third installation is on the island known under the name Isola della Giudeca, and consists of 160 incandescent lamps of Siemens make distributed through the streets. These lamps are coming into favour in Italy. In this installation current is supplied by two 9-unit dynamos made by Messrs. Alioth & Co., of Basle (the successors to the firm of Bürgin, Alioth & Co.). The approximate cost of the three installations is as follows: Lido, £1,600; public gardens, £2,200; Giudeca, £750.

Pocket Diary for Engineers.—We have received from the proprietors of the *Mechanical World* a copy of their new pocket diary, which they state is designed to meet a want which has been felt by many engineers and manufacturers for a handy pocket book which, while serving the ordinary purposes of a diary, would also contain a collection of practical rules and tables for every-day use in engineering practice. It is impossible to carry in one's mind all the rules and formulæ required by engineers. The majority of engineering pocket books are too bulky to be conveniently carried about, and the present diary, it is expected, will be found more serviceable in that respect. The diary is arranged a week to each opening.

Causes of Fire.—During the year 1887 out of a total of 2,363, some 180 odd fires were due to gas. This fact is given in the report of Captain Shaw to the Metropolitan Board of Works on the causes of fire in London.

Improvements in Dynamos.—Mr. Crompton in conjunction with Mr. James Swinburne has effected some improvements in dynamo-electric machinery which we had hoped to bring before the notice of our readers this week, but want of space and pressure of other matter compel us to defer the publication till a more convenient opportunity arises.

Barbados and the Telegraph Company.—Notice has been given in the Legislature of Barbados for a grant of £2,000 per annum for three years, as a subsidy to the West India and Panama Telegraph Company. Upon this a local journal remarks:—"The question of subsidies was understood to be under consideration by the executive committee, and we trust that the improvement in the condition of the Treasury will not induce the Government to forego the schemes for reasonable retrenchment in the public expenditure. With respect to the telegraph company, we think that the time has come for reconsidering the question. The manner in which the contract has been carried out has been a source of continual complaint. It is true that there has been a slight improvement in the new bulletins of late; we do not know whether this has been in view of the necessity which will shortly arise for discussing the terms of a new contract, but it certainly points to the necessity for insisting on more favourable terms for the public in any new arrangement which shall be made. The company derive a good revenue from their private business in Barbados, their chief customers being the mercantile community; indeed, beyond the mercantile community, and perhaps an occasional Government telegram, it is difficult to say what the general public derive from this large expenditure.

The Cable Rate War.—The directors of the French Telegraph Company—which severed its connection with the English pool, and was sued for breach of agreement in consequence—losing the action before the Tribunal of Commerce for the Department of the Seine, have appealed against the judgment, and in a circular to the shareholders express their belief that they will obtain an annulment of the previous decision. They will shelter themselves behind the Government, upon whose instructions they acted in cancelling the agreement with the English companies. From the published documents we gather that under its concession the company is prohibited from making any agreement with a foreign company without the formal authorisation in writing of the French Government. This authorisation had not been obtained, and when the present directors came into office at the end of 1886 they called the attention of the Government to the fact. The Minister of Posts and Telegraphs, M. Granet, wrote in reply that, in bringing about a fusion of its interests with those of the foreign companies, the French company was no longer in the position defined by the schedule under which it held its concession; consequently he called upon the directors to at once take the necessary steps to completely and properly carry out the clauses of the schedule. Those steps, he wrote in a later letter, could only consist in the cancelling of the agreements. So the French company only acted in obedience to the commands of the Minister, and it seems probable that the verdict which has caused rejoicing in the London cable camp will yet be reversed.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Willans and Robinson, Limited.—An agreement of 13th inst. provides for the purchase by the company of the business of the above-named firm for 980 fully paid shares of £50 each. Mr. Peter William Willans is to exercise the same share in the management of the company's business as he has hitherto exercised in the business of the firm. Mr. Willans will be entitled to a salary of £600 per annum so long as the paid-up capital is less than £110,000 and to a further sum of £100 for every complete £10,000 of paid-up capital beyond £100,000. Mr. Mark Heaton Robinson will also take part in the management and will be entitled to £500 per annum and to a further sum of £83 for each £10,000 of paid-up capital beyond the first £100,000. Sir Gilbert Augustus Clayton East, Bart., may take part in the management and while so doing will be entitled to £100 per annum and to a further sum of £17 in respect of every complete sum of £10,000 paid-up capital beyond £100,000.

Midland Electric Light and Power Company, Limited.—At an extraordinary general meeting of the shareholders in this company, held at 33, Waterloo Street, Birmingham, on the 9th ult., a resolution was passed under which table A of the Companies' Act, 1862, will cease to apply, and in lieu thereof, special articles of association will regulate the affairs of the company. The resolution was confirmed on the 30th ult., and duly registered 23rd inst.

London Electric Supply Corporation, Limited.—The statutory return of this company made up to the 30th ult., was filed on the 17th inst. The nominal capital is £1,000,000 in £5 shares. 42,000 shares have been taken up but no call has been made thereon. Registered office, 79 Grosvenor Street.

Electric Car and Power Company, Limited.—The registered office of this company is now situate at 50, Gresham Street, E.C.

House-to-House Electric Supply Company, Limited.—The registered office of this company is at 117, Bishopsgate Street Within.

NEW COMPANY REGISTERED.

Public Street Lighting Company, Limited.—Capital £10,000 in £1 shares. Objects: To carry on the business of public and private lighting in all branches, and to produce and trade in all apparatus, appliances and things used in connection therewith. Signatories (with 1 share each): J. Cawdy, 40, Queen Street; H. S. King, St. Swithin's Lane; H. B. Bartlett, Bow; J. B. Cawdy, Sidcup; T. J. Davies, Dulwich; H. O. Mellor, Marquis Road, N.; W. G. Breakspear, Tottenham. The first directors are Messrs. Hubert Barrow Doo, Frederick Hill, and Edmund Herbert Stevenson. Remuneration: 25 per cent. of net profits after 10 per cent. dividend has been paid. Registered 20th inst. by Andrew Mellor & Smith, 27, Clements Lane, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

Direct United States Cable Company, Limited.

THE twenty-first ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Friday last, Sir John Pender, K.C.M.G., presiding. The report submitted to the meeting appeared in the REVIEW last week.

The Secretary having read the notice convening the meeting,

The Chairman said the revenue for the half-year, after deducting out-payments, had been £23,003, and after paying working and other expenses a balance of £7,138 remained as the net profit for the half-year. That was at the sixpenny tariff. The balance of £7,138, with the addition of £5,004 transferred from the reserve fund account—out of interest received on the investments—made a total of £12,142, which had been appropriated in paying two dividends of 2s. each for the quarters ended June 30th and September 30th last. A dividend of 2s. a share for the quarter ended the 31st ult. had been declared, and would be payable on the 24th inst. The revenue at the sixpenny rate showed an increase of £3,399 as compared with the corresponding period of 1886, when the tariff was the same, but the progressive development in the traffic carried during the first half of 1887 had not been maintained. The expenses in London had been £458 less, but at the stations the amount had been £130 more. It was satisfactory to note that, notwithstanding the large traffic carried, and some additional outlay incurred through the action of the French Company, their total working and other expenses during the half-year had been less than in any previous half-year of the company's existence. The item of cost of removing their cables and station to Halifax remained for the present in the balance-sheet. Their investments continued to be worth much more than the company had paid for them. At their last meeting he expressed his belief that the sixpenny tariff would not be a permanent rate, but he stated at the same time that while the development of the traffic was going on, it would be a misfortune to make any change. They had, however, now arrived at a point when the sixpenny rate seemed to have ceased to bring an increase in the returns, and therefore the opinion he expressed at the last meeting as to the mode of dealing with the question he now entirely endorsed. The Western Union Company had taken an active part in the effort to settle the war of rates, and they had adjusted the land charges in a way which, he believed, was now working satisfactorily. That company had also acquired the control of the Baltimore and Ohio telegraph system. There had been some negotiations in America between Mr. Gould and Mr. Mackey, and they had been referred to this country, but the proposals were of such a nature that they could not be entertained. Had they accepted the proposals they would have been positively guaranteeing a very high rate of interest to a company which had laid cables that were not wanted, and, in short, it would have been giving a very high premium to that company. Speaking, he believed, with the full concurrence of his board, he would be very pleased to see a conference of the different companies held to consider the question of what would be a fair rate both for the shareholders and the telegraphing public. The suit which the Anglo-American Company had brought against the French Company for seceding from the pool had ended—at least, the decision for the time being was in favour of the Anglo-American Company, who had been awarded damages to a considerable amount. He could not say whether the decision would be sustained on appeal, but he believed if the directors of the French Company, instead of appealing to the Courts of law, appealed to the English directors as to meeting together and trying to bring about a more satisfactory tariff, it would be much better for telegraphy generally, and for the interests of all the shareholders. He made that remark with all courtesy and respect for the directors of the French Company, from whom he would be glad to receive a communication on the matter. He was not prepared at that meeting to say definitely what the rate should be, but if they could maintain the present traffic at a shilling rate, it would not be a burden to the telegraphing public, and the result would be much more satisfactory to the shareholders. Referring to the transfer of the cables and station from Torbay to Halifax, and to the removal to the southward of Brown's Bank of the short cable which had previously lain across the bank, he expressed a hope that by the latter operation they would in future be saved considerable expense. They were also prepared, being at Halifax, to carry their cable on to Bermuda, should the Government desire them to do so. He moved the adoption of the report and accounts.

Mr. William Ford seconded the motion.

Mr. Griffith and Mr. John Newton congratulated the chairman on the honours which had recently been conferred upon him by the Queen. A hope was expressed that the vacancy on the board, caused by the death of Lord Hawke, would not be filled up. Mr. Guesdon and Mr. Witherby thought the directors might, in existing circumstances, give up a part of their fees.

The Chairman, in reply, stated that for the present the directors did not intend to fill up the vacancy on the board. The agreement between the company and the Anglo-American Company was very beneficial, and would last for many years. The directors, under the articles of association, were entitled to 25 per cent. more fees than they had taken. They had to work at the present time very hard. It would be most imprudent of them to trench on the reserve fund proper, in order to increase the dividend. The motion was then agreed to.

Votes of thanks to the chairman and directors then brought the proceedings to a termination.

Eastern Telegraph Company, Limited.

THE thirty-first half-yearly ordinary general meeting of this company was held in the Great Hall at Winchester House, Old Broad Street, on Thursday last week, when the directors presented the report which appeared in the REVIEW last week. Sir John Pender, K.C.M.G., presided.

Mr. George Draper, the Secretary, having read the notice convening the meeting,

The Chairman, in accordance with his custom upon these occasions, gave a brief digest of the accounts. He said the revenue for the half-year ended September 30th, 1887, had amounted to £291,265, or £964 less than for the corresponding period of 1886. The directors, however, considered the figures satisfactory, because the decrease of revenue caused by the reduction of tariff to India was sensibly diminished, and the traffic with Australia, China, and other countries in the far East, had more than recouped the loss on the Indian messages. The traffic with Egypt, however, showed a further falling off; but that had been equalised by the increase of messages exchanged between Portugal and South America. Having so many points for the interchange of traffic, they found that the loss sustained in one direction was sometimes made up by gains in other directions. For the current half-year the prospects were most favourable. The traffic now showed a small increase each month, and it was hoped that when the next half-year's accounts were presented, they would be able to give the shareholders a bonus in addition to the 5 per cent. dividend. The total working expenses had amounted to £79,936, or £1,095 less; the general expenses in London had been £8,012, £48 more than in the corresponding period of the previous year. The working expenses at the station had been £56,386, showing a decrease of £1,743. The principal reduction, however, was in repairs and renewals of cables, which had amounted in the past half-year to £34,102, or £19,863 less than last year. Therefore, after charging all expenses, including income tax, providing for interest on debentures, debenture stock, and preference shares, they had been able to pay an interim dividend on the ordinary shares of 5 per cent. per annum, and to carry forward to next half-year a balance of £29,397, or £16,306 more than in the same period of 1886. The loss of income which had been forced on them at the Berlin Conference, as he had stated at the last meeting, caused for a time a suspension of the bonus; but as he had just said, they were now carrying forward a substantial sum. Until, however, they had closed the year, there was always the uncertainty that what might be a large sum to be carried forward, might be materially reduced by interruptions to the cables. He was hopeful, however, that as they improved the quality of the cables they placed in the sea, they would greatly lessen the repairs. If they could free themselves from the necessity of executing repairs, he need hardly tell them they would be able to pay a very handsome dividend. He referred last year to the fact that they had just completed their Tangiers cable. That had caused a good deal of diplomatic correspondence one way and another. The cable was found to be a necessity, the company accepted the position and laid the cable, which was now working, benefiting not only the Sultan of Morocco, but materially benefiting the company also. With regard to the difficulties they had experienced with the French Government in reference to the renewal of the concessions for their wire through France, although they were putting a good deal of money into the French exchequer for the use of the line, the Government had not yet consented to the renewal. But they had decided to make themselves thoroughly independent, and had laid a fresh cable from Porthcurnow to Lisbon, Gibraltar, Malta, and Zante. That cable was working in a most satisfactory way, and was aiding them in carrying out their traffic more satisfactorily, and placed them in a perfectly independent position if war should break out on the Continent. In these days of scares it was their duty, and it had always been their policy, to be ahead of the requirements of the Government and of the telegraphing public. Thanks to the policy of the directors, their system was now almost entirely duplicated. Had they been compelled to depend upon one wire during the interruptions that had taken place, the service would have been most unsatisfactory in every sense. Their dividends would have been lessened, and the tele-

graphing public would have suffered great inconvenience. Discredit would by these means have been thrown upon the whole system. They had entirely got the better of that state of things by duplicating, and in some cases triplicating their system. There were breakages now of which the public knew nothing, and which did not prevent them from conveying the traffic without any difficulty. The expenses for repairs appeared in the accounts, but there was no interference with the public or the dividends. The policy of securing a continuous system was the only policy which could make submarine telegraphy prosperous and great: it had become great through that policy, and the board was determined, in the future as in the past, to maintain that continuity so as never to allow it at any time to be said that the system was inoperative. He referred at the last meeting to the improvement generally in trade, and said that telegraphs were a capital barometer. He was glad to say that trade was still improving in the Colonies, as was evidenced by the fact that this company had all but recouped the amount of money they had been obliged to give up at Berlin, and thus attained a position which would enable them at the end of the financial year, not only to pay a dividend, but, he hoped, a bonus which might be in excess of 1 per cent.; at any rate, if they got back to the old 1 per cent. it would be satisfactory for the time, and if they could give the shareholders more they would always be glad to do that which would be appreciated. They might say, why not pay a dividend and a bonus now? But the directors had to look a little ahead. There was a great deal of excitement in trade at the present moment, more particularly in Africa, where it was said gold and diamonds were being discovered, and if they could believe all they read about the mines there, there seemed to be a probability of such an extension of trade and consequently such a traffic for them as would place them in a very satisfactory position indeed. Well, they were not quite disposed to be led away by very sanguine views. They believed that gold was to be found in quantities in Africa. They knew what gold-finding had done for California, and they hoped it would do something for Africa. A revival in trade and industry was greatly needed in Africa, and when it came it would bring increased traffic and increased dividends for the telegraph company. Six months hence they would know more accurately whether the "boom" was based upon a sound foundation. Another matter which would be satisfactory to the shareholders, as showing the position which the company held in the estimation of the commercial mind of the City of London, was the changing of their 5 per cent. debentures into 4 per cent. debentures. The 4 per cent. debentures were first issued at 96; but when they made the exchange the other day they were able to get a small premium, showing that they were considered a sound investment. There was still another subject upon which he must give them a little information, and that was the reserve fund. He wanted to show them how they had in a great many instances used the reserve fund to impart security to their dividends. If they had kept the reserve fund intact and laid new cables out of capital they would have added close upon half a million sterling to their capital. Instead of pursuing that course they had from time to time drawn from the reserve and from the annual income, and by those means had duplicated and triplicated their lines. If they had left the reserve fund untouched it would have been at that moment over a million sterling instead of £576,000. He thought the shareholders would approve of the policy of the directors had pursued in this matter. It was a bad thing to overburden the system with capital, and as long as they could pay a satisfactory dividend and secure that dividend by additional cables he thought it was the best policy for the company and for the shareholders. It might please the shareholders to have an extra 1 per cent. or so to-day, but that might leave them with nothing next year. It was their object to place the company in such a position that people might look forward with absolute certainty to 5 per cent., and to a bonus corresponding with the success of the company. He might mention that they had taken large sums out of the reserve fund —to duplicate the Red Sea and Indian Ocean cables, £100,000; for the triplication of the Red Sea and other cables, £300,000; and for the Sicily and other cables, £34,803—so that they had taken altogether from the reserve fund something like half a million of money simply to consolidate and strengthen their position. He thought he might fairly end his remarks by congratulating the shareholders upon the prosperous position of the company at the present moment; it was prosperous because it was built upon a sound foundation. Sir John then concluded by moving the adoption of the report and accounts.

The Marquis of Tweeddale seconded.

Mr. Lindsay Nicholson congratulated the chairman and the shareholders upon the results of the last year. It seemed that the deterioration culminated last year, and that with the improvement in metals and the revival in the shipping trade there was every prospect of a return to the old dividend and bonus next year. One question he would like to ask was, whether the cable to the Philippine Islands had been duplicated. They formed a very important Spanish possession, and it was necessary to take them into serious consideration. Mr. Nicholson then proceeded to speak in eulogistic terms of the services which the chairman had rendered not only to telegraphy, but by means of the telegraph to this country and the whole world, concluding by moving as a rider to the resolution: "That the shareholders of the Eastern Telegraph Company tender to Sir John Pender, K.C.M.G., their cordial congratulations on the recent honours conferred upon him by Her Majesty as some recognition of his services to Imperial and Colonial interests."

Dr. Waller seconded the rider, and added his testimony as an old shareholder to the energy and carefulness of the chairman in extending and preserving the interests of the shareholders.

The motion and rider were carried unanimously and enthusiastically.

The Chairman, in returning thanks, assured the shareholders that, greatly as the honour conferred upon him by the Queen was appreciated by him, he appreciated still more highly the honour which they had done him by placing in him not only now but through long years, the most perfect confidence as chairman of the company. If he were to attempt to give anything like a history of submarine telegraphy he would require to introduce a great many names, names, some of them, of men sitting round that table, and of others who had gone from among them; but, much as he had been indebted to every one of those men for their support and counsel in trying times, there was one whose name, even in the few words he had to say, he could not refrain from mentioning, one name which was closely and inevitably connected with submarine telegraphy and its progress. That man, he need hardly say, was his friend Sir James Anderson. Without Sir James's aid, without the advice of the other directors, and without the generous support of the shareholders he (Sir John) could have done little. Replying to Mr. Nicholson, he said that the Philippine Islands cable belonged to the Eastern Extension Company, which was now in negotiation with the Spanish Government respecting the matter.

The retiring directors, Sir John Pender and the Marquis of Tweeddale, and the auditors, Mr. Henry Dever and Messrs. Quilter, Welton and Company, were re-elected.

Mr. John Newton, in proposing a vote of thanks to the chairman, expressed the belief of the shareholders that submarine telegraphy had not yet received adequate recognition from those upon whom it devolved to award honours, and said he hoped the honour which had been bestowed upon their chairman was but an instalment of better things to follow. Had the chairman and his co-directors been men of the sword instead of men who had achieved great victories in a peaceful manner, he felt sure they would have been rewarded with seats in the House of Peers, where at present it could scarcely be said that telegraphy was represented at all, for although one or two of the directors were members of that august body, they had not gained their seats by reason of their connection with telegraphy.

The Chairman suitably acknowledged his re-election and the vote of thanks, and the proceedings terminated.

Anglo-American Telegraph Company, Limited.—The directors recommend the following dividends:—(1) A balance dividend of 10s. per cent. upon the ordinary consolidated stock for the year ending December 31st, 1887. (2) A balance dividend of 20s. per cent. upon the preferred stock for the year ending December 31st, 1887, both payable on February 4th next, less income-tax, to the stockholders registered on the books of the company on 16th inst. After paying the foregoing dividends, there will be an estimated balance of £2,300 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £1 7s. 6d. per cent. on the ordinary consolidated stock and £2 15s. per cent. on the preferred stock for the year 1887.

The Eastern Telegraph Company, Limited.—This company notifies that on and after February 1st the rate for telegrams to Turkey *viâ* Gibralter, Malta, and Zante will be reduced from 10d. to 7d. per word, being the same charge as by the Government land lines. The company suggests that telegrams for Turkey should be handed in at its own stations, 11, Old Broad Street, 41, Parliament Street, or 37, Holborn Viaduct. When sent from postal offices they should be marked "*via* Eastern." The coupons on the five per cent. debentures, due the 1st of February, will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard Street, E.C. Coupons should be left at the bank three clear days for examination.

National Telephone Company, Limited.—At the meeting of the directors on Wednesday it was resolved to declare a dividend for the six months ending December 31st last at the rate of 6 per cent. per annum on the first and second preference shares, and an interim dividend at the rate of 4 per cent. per annum (as against 3½ per cent. for the corresponding period last year) on the ordinary shares, and that the balance of £3,570 should be carried forward. The unaccrued revenue carried forward to the credit of next account amounts to £15,826, as against £38,722 last year.

The Western and Brazilian Telegraph Company, Limited.—Mr. W. S. Andrews has been elected chairman of this Company in place of Sir Henry Drummond Wolff, who has resigned his seat at the board. The vacancy has been filled by the election of Lord Richard Howe Browne.

Cuba Submarine Telegraph Company, Limited.—The directors, after providing for the dividend on the preference shares and placing £3,000 to the reserve fund, recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum, tax free, leaving £972 to be carried forward.

The National Company for the Distribution of Electricity by Secondary Generators, Limited.—Sir George Elliot, M.P., and Mr. Joseph Charles Parkinson have joined the board of this company.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

(*Continued from page 73.*)

DISCUSSION.

The PRESIDENT having intimated his desire that as far as possible the two papers which had been read should be treated separately,

Mr. GORDON was called upon to open the discussion. He said he had no desire to criticise such beautiful instruments as Dr. Fleming had devised for them, and if he did make any remarks which could be construed into criticism it must be understood that they were uttered with the full feeling of how much the profession owed to those who took such pains to devise instruments for the practical measurement of volts, and how important it was that every little practical difficulty should be eliminated as fully and as soon as possible. He proposed to speak more from the point of view of what was required in the engine room than of what was wanted for laboratory purposes or for general testing. These latter were special requirements; but what was most wanted was a voltmeter that could be placed on the circuit, and be as easily read as an ordinary steam gauge. They wanted voltmeters, not such as only the skilled electrician or the foreman workman could read, but such as the driver at 30s. a week could attend to. If they had a large electric light station with a lot of different circuits, all of which had to be regulated, they did not want to have a man to look after the instrument who understood the theory of it, but simply to tell the driver to turn the handle to the right or the left according as the volts were to be increased or decreased. For this reason one or two criticisms occurred to him upon Dr. Fleming's paper. The first might seem a very trifling one, yet he thought it might not be without practical value. It was this: the dial of Prof. Fleming's instrument must necessarily be horizontal. Now they could not get a man to watch 15 or 20 horizontal dials all night, for if he dozed for a minute he could not watch them; whereas if they were placed opposite him in a vertical position there was very little excuse for his making a mistake with them. There was one other small practical objection—or rather two objections in one—which he saw to Dr. Fleming's instrument. First of all the current passed through the spring. Dr. Fleming had met that objection to an extent by saying that the expansion of the spring partly counterbalanced the difference of resistance of the current coils. Still he had $\frac{1}{10}$th of an ampère going through. He should imagine that that would give a very considerable current density in the spring. He did not know what the section of the spring was, but imagined it must be sufficient to give some hundreds of ampères per square inch, and that would produce a perceptible heating effect. He did not profess to be an expert in springs, but he imagined that the amount of current would in some degree alter the temperature and tension of the spring. He would suggest one slight addition to the instrument. If by any chance, or by negligence, the instrument was put away, that was to say, if the lid was shut and the fixing lever screwed down, before the current was taken off, a spark occurred at the point, and by that means the point was damaged. It seemed to him that it would not be difficult to alter that. With regard to the Cardew voltmeter, it was very delightful to see such a beautiful development of Captain Cardew's principle as Prof. Ayrton had shown them. But however much they were pleased with this development, they must not forget what they owed to Captain Cardew for having given them the principle. They must remember, too, that that was not a mere theoretical principle, but that the instrument, though confessedly not perfect, was in working form. His experience with the Cardew instruments was this: for 11 months he had 18 instruments in the instrument room with the current constantly on them day and night, and they practically worked perfectly, though they required a certain amount of tension. First, however, they had to take them to pieces and remake them. In graduating them they always found it necessary to keep the current on at least two or three days, the current making a deflection about equal to the 150 volts they wanted, so that the wire might get rid of any permanent sag that it possessed. They wanted to know whether they had 145 volts, and did not care for any other part of the scale. But even in the part of the scale which they used there was a slight shifting; it was never quite constant, and had to be altered from time to time. They could not be always altering them, so he took the covers off and moved the dial round from 30 to 40 degrees. They put the instrument to be set on the same circuit with a standard instrument, and turned the dial until the points they wanted came to where the needle was; then the instrument was right for the day. They kept one instrument as a standard; it was a very good instrument, and they took very great pains with it. It was tested once or twice a month with a Thomson galvanometer, a condenser, and one of Latimer Clark's cells. The instrument worked well enough to keep the lights constant, and there was nothing to complain of. He had before tried instrument after instrument, but they would not work; some worked for a week and some for a month, but all went wrong ultimately. As to the differences of sensibility, they tried many means. He even went to the length of putting up a Cardew voltmeter 30 feet long, using an iron wire for the experiment, but it was not in any way practically successful. So they went on, and they were very thankful for what they had got, but were always wanting a development of the same thing, and that development he believed Prof. Ayrton had given them. In looking at new instruments they must not only think of those who had to make them, but of those, also, who had to use them. Electric light engineers had to take contracts to keep their E.M.F. absolutely constant, within certain limits, and it was an important matter if the instruments went wrong. It was no use telling the business directors that there was a technical difficulty; they said they did not know anything about that, but they did know that they had been got into trouble with their customers. Prof. Ayrton's instrument seemed to him very nearly perfect, so far as could be judged from the short notice which had been given. There was one point about it which the author had not mentioned: it was the only voltmeter he had ever seen—not even excepting the Cardew, he believed—which had no current in the spring, and that being the case, he could not see that there was any possible source of error. Prof. Ayrton had pointed out the importance of getting a uniform graduation all round the dial. That was not always all they wanted. In an engine room voltmeter they did not care a bit if it was 10 volts wrong, but if they were going to work at 120 volts it was absolutely important to know whether they were running at 109, 110, or 111 volts. He would venture to ask Prof. Ayrton whether, by increasing or altering the sag, they could make the instrument more sensitive at any particular point.

Captain CARDEW said Dr. Fleming's instrument was a very pretty electro-dynamometer, and having the poles in the centre seemed to be an advantage. He supposed the length of the fixed solenoids had been considered; on the diagram they seemed rather long. The most striking thing in the instrument was the very small weight of the suspended coil, if it was wound with German silver wire, as Dr. Fleming said it was. This was not, of course, a direct reading instrument, and belonged to the electro-dynamometer genus. They would expect him (the speaker) to know more about the other instrument. He saw Prof. Ayrton's very beautiful instrument that day for the first time, but that was not by any means the first time that the idea of combining Prof. Ayrton's magnifying spring with his own principle of using the expansion of the wire had come into his head. Many times he had been on the point of writing to Prof. Ayrton about it, but had never done so; now he was agreeably surprised to find that he (Prof. Ayrton) had worked it out himself with the most consummate ability. If he had known of this before he would have brought an experimental instrument of his own which was something like the one before them, with the difference that the wire was pulled in the middle. It was read by means of a lens, the motion of the wire being read against a photographically divided scale. He had read somewhere of pulling the wire in the middle and thereby getting for the expansion of the wire very much greater motion than by the ordinary means. This was suggested to him by Dr. Muirhead a great many years ago. Of course the drawback of using this method was that the increase of motion was obtained at the expense of putting very much more stress on the wire—that was to say, if you used anything like the same spring to pull with. By pulling at the end of the wire you simply impressed a certain amount of tension on the wire, but if you pulled in the middle with anything like the same force you put an enormously greater stress upon the wire. When the motion was increased a much weaker power was required to effect it; if the full power were put on the wire would probably break. The needles in Prof. Ayrton's instruments were not suitable, in his opinion, for such voltmeters as Mr. Gordon spoke about. The latter's engine driver, if he had read with such needles, very much, would be apt to lose his wits. They were hardly visible, even when standing close to the instrument, without a magnifying glass. With regard to the double barrelled gun form of instrument which was upon the table, he might say that wooden boxes had been rather a source of error, for the whole of the mechanism being fixed on to a piece of wood the temperature was constantly changing, and they could not expect the gear to work very well. At Enfield he had used a voltmeter of greater length than the specimen in his hand, with 8-inch dials and a big handle. It was specified that a man could read this instrument at a distance of 40 feet. They found after the instrument was constructed that in the position in which it had to be fixed the man could not possibly get more than 2 feet away from it. It answered capitally for the purpose for which it was required, and was a great improvement upon previous forms. It was a totally new instrument, and was very difficult to deal with at first. It used to go off at a tangent upon some particular line, and this led to a lot of instruments being made which were defective. A lot were made with cut springs instead of spiral, and these gave a great deal of trouble. But when they were once firmly established and the spring and wire had attained their final condition, which was not until the current had run through them for some time, they were quite satisfactory for the kind of work to which they were applied. Prof. Ayrton had employed a much smaller fuse wire than was usual, and he had been able to do that because he had got a spring which would give him the motion with hardly any pull at all. The instrument possessed all the advantage they would attempt to get with a larger needle and a much stronger spring, and therefore he was able to use very much finer wire; and the finer the wire, the more instantaneous the expansion and contraction. It was chiefly due to the finer wire that he got the rapid motion of his needle, but it was also due, to some extent, to his having done away with any gearing. Prof. Ayrton's instruments were very beautiful, and one of them was particularly ingenious. There was a great deal too much mass, but it would no doubt be very much modified in that respect. One point had occurred to him in relation to the question of compensation. The wire had to be enclosed in a tube, or some equivalent to a tube, of such metal

that any variation of external temperature would cause the zero to vary. If an iron tube were used and a silver wire were put in it and stretched and the index put at the end (of course when the weather was hot), the zero must alter, because the silver would expand much more than the iron. He thought there would be some difficulty in arranging for that. As regards the question of the final temperature at which the instrument would arrive when the current had been kept on for some time, that action was made use of by the finer wire. Of course they could not have the thing get red hot, and it was a question of surface. They must have a certain surface to radiate the heat. Probably that had been thought out, but Prof. Ayrton talked of putting very high voltage on to a comparatively small surface of metal. However the wire was arranged, with a certain current there would be a certain amount of heat developed; that must finally come out of the metal surface, and it was very important that that should not get too hot, As he had never described a voltmeter before the Society, he would like to put on the board a standard form which anybody could make for himself. Having given a diagrammatic representation of his standard instrument, Capt. Cardew asked Dr. Fleming if he had found the point in his instrument deteriorate under the action of a current. His experience of iridium points was that they wore very rapidly indeed.

Mr. PREECE here suggested, as the hour of closing had arrived and several gentlemen whom the meeting wished much to hear had not yet spoken, that the discussion should be adjourned for a week.

The PRESIDENT took the feeling of the members upon the suggestion, and it was unanimously decided to adjourn.

Prof. AYRTON said he wished before the meeting terminated to say a word or two to remove a misconception. Mr. Gordon had spoken of the inexcusability of keeping the engine driver awake all night looking at the horizontal dials; but fortunately his (the speaker's) instrument could be used quite as well vertically as horizontally, and the engine driver, knowing this, could go to sleep quite happily.

The meeting then adjourned.

At the adjourned meeting on December 1st, Sir CHAS. BRIGHT again presiding,

Mr. ALEXANDER SIEMENS said he was very glad to have heard Dr. Fleming's paper and to have seen the new form of dynamometer which it described, which instrument he thought was upon the lines of one originally designed by a member of his firm. He had brought an instrument to the meeting which showed the latest form of the Schüster dynamometer. In using it they employed mercury cups, which worked perfectly well on land, but they found that they could not use the instrument on ships; further, the instrument indicated the current in the proportion of the square roots of the reading, and this made the range of one coil very limited. They had partly overcome that by putting two coils on all the dynamometers so as to have a greater range. Some time ago Mr. Raworth, who was at that time in the employ of the Siemens firm and very much engaged in the fitting up of ships, hit upon a plan which had been constructively carried on at their works ever since. It was to have a dynamometer of great range and which was direct reading, the current being directly proportional to the deflections. At the same time it had no movable contacts, which he was afraid would prove rather a drawback in Dr. Fleming's instrument. He had the actual instrument there. Dr. Fleming said it would be bad to have iron in a dynamometer owing to the vibration of the remanent magnetism. They had overcome that difficulty in this way: there was a cylinder of iron which was pivoted between two fixed points in the usual manner, so that the friction was reduced to the smallest possible amount; it carried two iron arms which were very thin and flat, and at right angles to these arms was carried a pointer, as in the other dynamometer; at the top was a spring which counteracted the influence of the current. With a very small current these two thin iron arms were magnetised to their fullest extent, and they had a handy instrument which would read from 10 to 320 ampères and might be used in any position, all the movable parts being balanced and there being no loose contacts anywhere in the instrument. All the convolutions were fixed, therefore it was a very handy instrument to be used on board ship. It had, however, the same drawback that all spring dynamometers possessed, it could not be left in circuit for a long time with the spring on without getting a permanent set in the spring. It was therefore advisable to provide a switch, switch the instrument in for a short time, take the reading and then take the instrument again out of the circuit. He had there an instrument for determining the values of alternating currents, constructed by Sir William Siemens. It was the same as the other, only that the fixed coils had many convolutions of fine wire, and the direct current went through the swinging coil. They took their measurements by passing the current through the two instruments in succession, and they got in the one the watts and in the other the ampères. Then, dividing the one by the other, they got the volts of the alternate current. It would be seen that with so many convolutions there would be a great deal of self-induction; and they could not graduate the instrument for continuous currents and then use it direct with alternate currents. But it was possible to graduate this instrument for a certain number of alternations of alternate currents, and they could use it perfectly well. If they had a large central station, they would have an engine running very nearly always at the same speed, and if their instruments were graduated to that they could use it. It was, however, a complicated affair, and they had not pursued it. The instrument which Prof. Ayrton had brought forward as an amendment was very much better adapted to the measurement of alternate currents, and therefore it was of no use to have those cumbersome things with the divisions if they could get a neat instrument like that. With regard to using strips, he thought it would be historically interesting to bring there some old instruments constructed according to the idea of Sir William Siemens. One was a current regulator. It had a little lever attached, and it was intended to have a pencil or some writing arrangement, and a strip of paper was to be carried past this point, so that a record was kept of the strength of the current and its variations in that particular circuit. He found in the patent proceedings of June, 1878, a reference back to a patent in 1877 which was taken out by Mr. Clark as a communication by Mr. Lontin, who described an instrument which was regulated by having a metal strip, the variation of the current being shown by the extension of the strip. He merely brought these things forward as a sort of historical development of the graduating instruments of Prof. Ayrton.

The PRESIDENT said he wished, alluding to a point in Dr. Fleming's paper, to put on record that so long as 35 years ago his brother and he had taken out a patent (14,331 of 1852) for a very similar arrangement to that described for ascertaining the exact amount of force of the current which would give an invariable result. It was well-known that the ordinary needle galvanometer gave no exact test of the magnetism in the needle, which was continually varying. This they proposed to obviate by making a coil react upon a coil, one coil being fixed and the other moving, the current passing through both.

Mr. J. E. H. GORDON said as they were discussing measuring instruments it was a good opportunity to bring forward an instrument which had been brought to his notice, and which was manufactured in the particular form shown in Germany. His apology for bringing it forward was that it had not yet been much seen in England. It was intended as a domestic meter, to act like a gas-meter, to be put in a house to register ampère hours; when they had the ampère hours registered they had the constant volts and the total number of Board of Trade units used in the house. It was very important for the commercial development of the electric light that there should be such a meter, as they got rid of the necessity of charging a fixed rental per annum, and were able to charge according to the actual consumption. He would presently speak about the authorship of the meter, but he would now speak of it as Dr. Aron's, because that particular form was manufactured by Dr. Aron. The principle was this: there were two pendulums, one an ordinary pendulum with a brass weight, and the other a pendulum with an exactly similar weight, with the exception that the bob consisted of a permanent steel magnet. Underneath the steel magnet bob was a coil of thick wire or rod. If there was no current passing round the rod the two pendulums would travel at exactly equal speed, but if there was a current through the coil one would go more slowly than the other. The clockwork was differential. There were two sets of clockwork, whose speed was regulated by the two pendulums respectively. The speed was indicated on the dials. If the two pendulums travelled at equal speeds there would be no motion, as the forward exactly equalled the backward motion; but if the pendulums travelled at different speeds there would be motion in the pointers proportional to the different speeds, that was to say, proportional to retardation, that was the integral of all the currents throughout the time for which the instrument had been working. The principle was so simple that very little need be said upon it. There were a few mechanical points of interest. Theoretically, the instrument might be allowed to go on all day without any current; the pendulums would travel at the same speed and there would be no result. As soon, however, as a single lamp was put on sufficient current passed through the magnet to pull the spring down, and that made contact and sent a little current into the shunt magnet; then the pendulums varied in speed and continued to do so as long as there was a current passing. If the current was very small the difference of speed was very small, and there was scarcely any motion. He brought the instrument forward because he believed it was in a practical form for actual use. But there they were dealing more with the scientific action. They must remember that the principle of the instrument was first explained by Profs. Ayrton and Perry. He thought he might go as far as to say that the inventor of that instrument had asked Prof. Ayrton's permission to manufacture it. Such as it was, the instrument was now manufactured by Dr. Aron, of Berlin. He had not tried it practically himself, but Mr. Crompton had told him that he had made careful experiments and found it extremely accurate and practical.

Capt. CARDEW said he thought, in a little experimental instrument he had brought with him, they would see the prototype of Prof. Ayrton's new instrument. It consisted of a wire stretched along with a pull in the middle by a spring. One end of the spring was screwed down and formed a pointer. The observer looked through a little magnifying glass, and behind the pointer, not as near to it as it should be, saw a photographically-divided scale—an ordinary little photographic film divided into lines with figures. He did not follow this out, because it struck him that pulling the wire in the middle was dangerous unless it was pulled very slightly, and if only pulled slightly the friction would probably cause error. By itself, without Ayrton and Perry's magnifying spring, he did not think there was much in it, and he merely brought it up as a curiosity.

Mr. W. B. ESSON: Speaking as a maker and user of electrica

measuring instruments, I cannot see that the forms of instrument introduced by Dr. Fleming possess any advantages over several forms already before the public. All that Dr. Fleming's voltmeter is capable of doing can be performed by a finely wound Siemens dynamometer, and that without taking the current through the spring, which is, I think, decidedly objectionable. We know that the elasticity of springs remains under ordinary conditions very constant for long periods, but it is doubtful whether in the present instance the value of the constant will not be altered by the continuous heating and cooling or expansion and contraction due to the current flowing through the spring. I presume Dr. Fleming means his instruments to be used only as standards, and not for installation work. For the latter we require indicating instruments which show from moment to moment the E.M.F. or current flowing. Zero instruments, in which before an observation is made the movable part has to be balanced by the observer, are quite unsuitable for installation work. As regards wattmeters, I doubt whether the profits to be derived from their sale compensates for the trouble of designing them. Out of some thousands of instruments sold by my firm we have only managed to dispose of some half-dozen wattmeters. It seems to me that this kind of instrument is of very little use. People not only require to know the power expended in the circuit, but also how the product of ampères and volts is made up. Dr. Fleming truly said that this knowledge could be obtained by using a wattmeter in combination with a voltmeter, but of course it can be equally well obtained by using an *ammeter* and voltmeter. But leaving Dr. Fleming's instruments, I have brought down to show at this meeting one of our standards, in which all will, I think, be interested. This standard, I may say, is the largest in creation. It measures 2,500 ampères, and was designed by Sir W. Thomson. It consists of a movable ring supported above a fixed ring, the former being suspended by two ligaments, each consisting of 900 copper wires one-tenth of a millimetre diameter lying side by side. The bottom ends of the ligaments are attached to two pins projecting from the sides of the movable ring towards its interior, the top ends to two pins fixed above these. The current divides in the movable ring, half going round each side, while in the fixed ring it circulates in one direction only. There is consequently attraction between the fixed and movable rings on one side due to the parallel currents and repulsion on the other side due to currents flowing in the opposite direction. The force tending to tilt the movable ring is balanced by a sliding weight, its position indicating the current flowing. Mr. Joyce, who does our calibrating work, would tell you that the instrument is a very difficult one to use. When the scale beam is nearly balanced the slighest pull on the cord which moves the sliding weight is sufficient to make the beam kick dreadfully, and it is almost hopeless to attempt balancing the current unless the latter is extremely steady. As a matter of fact in using the instrument we have to move the weight to a definite position and reduce or increase the current very gradually until a balance is obtained, noting at that instant the deflection on the instrument in series with it which is being calibrated. A spring instrument where the force is put on very gradually is much easier to use, but springs, on the other hand, may lack the constancy of weights. Coming to the Cardew voltmeter and its ingenious modification introduced by Profs. Ayrton and Perry, there are, I see, several of the latest forms of the former on the table. In this one made by Messrs. Paterson and Cooper there are expended about 40 watts, and the temperature of the tube rises to about 150° F. I should think. From the figures given me by Prof. Ayrton last week, I find the watts expended in his instrument about the same, but from the fact that in his the radiating surface is very small, I should think it would rise to a much higher temperature. The question would then arise whether the heating and cooling would not affect the permanency of the springs. Prof. Ayrton said that a certain initial sag had to be given to the wire. I should like to know what adjustment there is for insuring that the sag will be the same when the instrument is re-wired. In an instrument constructed on the Cardew principle it is most important that the least difficulty be experienced in re-wiring should the wire break or fuse. In the form made by us the wiring is most simple. Though I have never re-wired an instrument, I never considered it a very formidable task until I saw Prof. Ayrton's. His instrument I think must be very difficult to wire. Probably the best way to determine whether the new or old form is the easier would be to have a race. Prof. Ayrton would start re-wiring his, I mine, and the one who finished first would be the winner.

Mr. S. EVERSHED said he, like, he supposed, everyone else, was very much delighted with the appearance of Dr. Fleming's instrument, though he had expected to see something nearer the size of Sir Wm. Thomson's. The fact of its being smaller, however, was an undoubted advantage when the instrument was to be taken about. A good deal had been said about the engine-driver going to sleep. He thought he might go to sleep with that instrument in any position. He called this a zero-reading instrument; an instrument in which the scale indicated the E.M.F. or the current, without any adjustment on the part of an observer, was what he called a direct-reading instrument. Everyone had said something about a spring. He would certainly prefer an instrument without a spring, and he could not see any reason why the leads should not be carried in direct without the intervention of a spring. No one had said anything about the temperature errors of springs. He had not had large experience with them, but he suspected that they had a kind of temperature coefficient. He would very much like to know whether they had, or whether they were simply spoiled by rise in temperature. He was rather surprised that Dr. Fleming should have used platinoid in winding his instrument, for, as far as his experience went, if they wound an instrument of that type with copper and put platinoid in series with it, they spent much less power than if they wound with platinoid. Of course there was then an error in heating, but that could be compensated; by the method devised by Mr. Swinburne and brought by him before the British Association at the Manchester meeting Dr. Fleming's instrument could be easily compensated. As to the wattmeter, he did not agree with Mr. Esson about the uses of that instrument. Of course the latter was speaking of wattmeters used in engine works. His (the speaker's) experience had been mainly in lamp factories, and Dr. Fleming's wattmeter was intended for use in lamp factories. In the Hammond Company's lamp factory he (Mr. Evershed) for some months used a roughly made wattmeter, direct-reading, not zero-reading, and he calibrated it in candles. A girl about 14 tested an enormous number of lamps by that wattmeter, because she was able to get candles on the wattmeter and on the screen simultaneously in a short space of time, and while conducting the operation was able to sing hymns continually. No doubt she might have got through a great many lamps with Dr. Fleming's instrument; but he did not think she would have sung the hymns. He had intended to say something about the compensation of instruments in general. The subject was brought to the notice of the public by Mr. Swinburne at Manchester; but he (Mr. Evershed) had been working at it practically for some time. His instruments were not yet ready, but he hoped to bring them before the society some time next year. It would show an accuracy of one part in 10,000 for any temperature they were likely to get in England, and moreover it might be left off and corrected for its own error, so that it did not matter where the temperature came from, the instrument would not be out more than one part in 10,000. Coming to Ayrton and Perry's low-reading voltmeter, it seemed to him admirably adapted to the testing of secondary cells. There was a distinct want of an instrument reading up to 5 volts. They had not been able to bring out a satisfactory instrument, although they had made a great many experiments. Profs. Ayrton and Perry seemed to have objections to gearing; but if they wanted something that could be knocked about by engine-drivers the Cardew voltmeters on the table were thorough engineering instruments; they were solidly made, and the use of gearing enabled them to do away with the objectionable silk passing round the wheel. It was very difficult to get good gearing, but the perfect curves they got with those instruments showed that the rate at which the pinion turned exactly corresponded with the rate of rotation of the wheel. Mr. Esson had said something about the power spent; but he (Mr. Evershed) thought he must have been thinking simply of the spring. In a small instrument reading up to 10 volts the power spent appeared to him to be very small; he thought it came out at not more than two watts. An instrument of that size could be safely left on. Coming to the bicycle form, he thought it greatly resembled the web of the geometrical spider. In the instrument on the table, which read up to about 170 volts, the power spent was something like 50 watts. The surface of that instrument was not sufficient to radiate the heat, and consequently it became unduly hot. In his instrument he found about 5 to 7 inches would do for a watt; the instrument got quite hot enough, and he was quite sure they could not leave it on with 170 volts. One of the charms of the Cardew instrument to him was that it could be left on. There was a very curious point which he had come across in making Cardew voltmeters with respect to the relative energy radiating by fine wires and by thick wires. If they had a given length of two wires of different thicknesses and passed a current through, raising them to the same temperature, taking the deflections on the dial as the indications of the temperature—they did not know what the temperature was, but they knew that it was the same temperature if they had the same deflection, provided the position of the wires was the same—they might think it took less power to keep the fine wire at that temperature than the thick. Captain Cardew had said that it did; but he had found that it did not. In the first experiment he made the fine wire positively took more power. He repeated this experiment very carefully. He took one volt and used strains proportional to the breaking weights of the wires. The different sizes of the wire was 1·4, 2·5, and 3·5. The wire was apparently in the same position. Upon each occasion he raised it to 280 degrees deflection, which he knew corresponded roughly with 200° C The indications then came out, for the wire, 1·4, 38·2; 2·5, 36·9; 3·5, 32·2. He would not at present say that those figures were exactly right, because it was impossible to know the exact position of the wire, and yet it was absolutely essential that it should be known. It was quite clear, however, that the power did not diminish as the size of the wire diminished. There was not the slightest room for doubt that those experiments, which he had twice repeated, gave a correct representation of the facts. As to the explanation, he was completely in the dark. Of course the practical manager of a factory had not too much time to make experiments. To use platinum-silver seemed to have been a happy idea. He had had a platinum-silver wire for six months and had subjected it to a strain the whole of that time by means of a dead-weight; the result of his observations was that they might absolutely rely upon platinum retaining its length.

Mr. JAS. SWINBURNE: Electrical engineers must be glad that Messrs. Fleming and Gimingham have brought out an instrument, for we may be sure that great care will be taken in calibrating it. Though a few makers calibrate their instruments carefully, inac-

curate calibration is a much more common fault in the various instruments in the market than bad design. Those who have spent much time designing instruments in which the force between two wires carrying currents is measured must have come across the difficulty of arranging the coils so as to get a large force with little waste of energy in a zero instrument without making it in unstable equilibrium. For instance, two fixed coils of the same size with a common axis are in unstable equilibrium when the current attains a certain value. One cannot but admire Messrs. Fleming and Gimingham's ingenious way of getting a large force with stable equilibrium. Their arrangement also prevents errors from the instrument being out of balance, as the induction is practically radial. I presume the diagrams are incorrectly drawn, and that the direction of the current on one side is really the reverse of that shown. The instrument is then unaffected by neighbouring dynamos, being astatic. Instruments with one moving coil have to be read twice with the current in different directions under such circumstances, the mean between the readings being taken. I do not think there is any objection to bringing the electricity in by the spring; the surface is so large, and the current density so small, that there is no perceptible heating. Taking it out again by a metallic point seems much more objectionable. I have tried making contacts through points on which the moving coil rocked, but found that the instrument soon lost its sensitiveness. I have also used two springs; the electricity came in by one and went out by the other. This works very well, but it is difficult to apply to zero instruments. The temperature error cannot be large, as the cheapest watch is a very accurate instrument compared with a voltmeter. A temperature of 100° does not seem to weaken the springs used in safety valves and indicators, so there is no reason to suppose voltmeter springs would vary. I am glad to see the prejudice against springs dying out, and hope to see that against permanent magnets follow. Messrs. Fleming and Gimingham do not say whether they intend their instrument for alternating currents. If so, there will be an error due to the mutual induction of the coils when used as a wattmeter. This is absent from Siemens's. A method of compensating for wattmeter errors was also explained in my British Association paper already referred to; this can easily be applied to the instrument before us. Whenever I can possibly do so I "go for" Professor Ayrton, partly on principle, but chiefly because I think he likes it. To-night I cannot do so. I very much regret it. Everybody has coveted Captain Cardew's hot wire, and each of us has wished he had invented Professors Ayrton and Perry's beautiful helical spring. It is exactly what one wants in designing all sorts of instruments But if Profs. Ayrton and Perry wish to raise this beautiful instrument above the level of a voltscope I think they must compensate. Captain Cardew's voltmeter has to be compensated by making the case with the same expansion coefficient as the platinum silver wire. As the case cannot be made of platinum silver it is made of brass and iron. It has also to be corrected for alterations of resistance with varying external temperatures. In measuring alternating currents a voltmeter that measures the root of the mean square is of no use on the primary circuit. Secondary circuits, again, nearly always feed incandescent lamps. People do not seem to realise that lamps do not behave like dead resistance; they flicker to some extent, especially if the carbons are thin. This makes them apparently run at a higher efficiency and break sooner. A fine wire voltmeter, such as Professors Ayrton and Perry's, must flicker to some extent also, so that this error is beneficial. In using a hot wire instrument for alternating current work, several assumptions are made which do not seem altogether warrantable. First, it is assumed that the wire radiates heat uniformly without flickering. Second, that the current density is uniform throughout the section of the wire, or that it corresponds to the current density with a direct current, which is not quite uniform because the inside of the wire is hotter than the outside. It must also be remembered that the mutual induction of the current streams affect the current density with alternating currents. Third, that the temperature throughout the cross-section is the same as with the corresponding direct current. Fourth, that the instrument has no appreciable self-induction. I have not calculated it out, but it seems as if a very thin wire might cause a sensible error, and would like to know if anyone has calculated the self-induction of a Cardew and of a Siemens instrument, or measured it.

Lieut.-Col. ARMSTRONG asked Prof. Ayrton what was the effect of external changes of temperature upon his instruments. He would like to know, also, to what extent the instruments might be used as standards. He did not recollect that anything was said as to the degree of accuracy to which they would work.

Mr. C. H. GIMINGHAM, joint author with Dr. Fleming of one of the papers, called upon by the President, said he endorsed all that Dr. Fleming had said, and had nothing to add.

Capt. SANKEY enquired what kind of fuses Prof. Ayrton put on his instruments.

Mr. SPAGNOLETTI asked to what extent the instruments had been practically used.

Mr. GUMPEL thought the discussion had been allowed to wander too much from the real points before the meeting. With regard to Dr. Fleming's instrument, it struck him that, generally speaking, it was not the instrument of the future for the workshop, for the simple reason that it did not avoid the disadvantages of the Siemens electro-dynamometer. It opened the door to self-induction, and it was too elaborate; it should be classed as an instrument much more for the laboratory than the workshop. Since they had been wandering so much, he would refer to Dr. Aron's meter. Seeing Mr. Gordon setting the pendulums going had reminded him of Charles V., Emperor of Germany, who sought to get a number of pendulums to swing together, and found the greatest imaginable difficulty in doing so. Anybody who had tried to adjust pendulums for accurate time keeping would know that it was no easy task. Those two pendulums, however closely adjusted, would show a certain difference, which, to his mind, rendered the accuracy of the instrument doubtful. The point he chiefly desired to ask about was whether Prof. Ayrton found that the repeated extension and contraction of the platinum wire against the spring affected the accuracy of the instrument.

Dr. FLEMING, on behalf of Mr. Gimingham and himself, returned his sincere thanks for the very kind way in which his paper had been received, and for the very valuable criticisms made upon the instruments. He agreed with many things which had been said, most cordially, particularly with what fell from Mr. Gordon respecting the pressing want of a good engine room voltmeter, one which could be seen across a large engine room. Their intention had not been to produce an engine room voltmeter properly speaking, and therefore he thought he cut away the ground from under Mr. Gordon's feet. With regard to the criticisms on the subject of current density in the spring, he had not given the dimensions of the spring. It was formed of steel wire of rectangular cross-section, the dimensions being 6 mils. by 8 mils. The current density was about a thousand ampères per square inch. That was quite an allowable density for large contacts, and was practically small for wires of small section. The spring, when the instrument was left on the circuit, did not become of greater temperature than 60°. The lid was so arranged that it could not be shut down without taking off the wires, and the act of shutting down the lid was so arranged as to lift the movable coils to the right position. Turning to the instruments which Mr. Siemens had presented to them, there was no doubt that the instruments now brought forward were of precisely the same type; the principle of the dynamometer was seen in both. He believed the first person to arrange an electro-dynamometer was Weber, and although he did not know the exact date, it was certainly before the year 1852, and probably was some time in the thirties. He was very glad to see on the table an instrument of Sir William Thomson's. He had received a letter from Sir William describing the instrument, and saying that he had varied it in several respects since it was exhibited before the British Association. They had in their laboratory two Thomson current meters which were used constantly as standards. They could not but be beautiful instruments, seeing the immense ingenuity and wonderful theoretical knowledge which Sir William brought to bear upon all he did. At the same time the instruments were inconvenient as portable standards. They required to be very carefully arranged, and they only used their instruments as standards for checking the other instruments. He agreed with Mr. Esson that there was a difficulty in reading when the current was slightly unsteady. It was more easy to use the weights to determine the current than the current to determine the weight. The one and three ampère instrument was a very valuable one. It was rather different from the form on the table; a movable coil was placed between the fixed coils, a beautiful contrivance by which the weights were gradually added one after the other until balance was obtained, and, if necessary, the current could be determined to one part in a thousand. Sir William Thomson told him that he had greatly improved the instrument with regard to quickness in weighing, and it now took no longer than to get a reading on an ordinary tangent galvanometer. With respect to the effect of the current on the elasticity of the spring, sometimes objections seemed to be very formidable in theory but did not turn out to be very difficult to meet in practice. They had tested the instruments by keeping them on the circuit for some time, and had found that there was no alteration due to the change in the elasticity of the spring within the limits in which the instruments were intended to be used. He was very glad to hear Mr. Evershed's remarks for the reason that he had paid great attention to the manufacture of electrical measuring instruments. He (Dr. Fleming) agreed with Mr. Evershed that an instrument partly wound with platinoid and partly with copper took less power than one wound with German silver. But with German silver it was not necessary to provide people with the variation coefficient. If a voltmeter were wound entirely with copper wire, although the coefficient might be given on the inside of the case, together with instructions to add or subtract volts according to the temperature, how were persons in practice to make the calculation? What would be the effect if that instrument were wound with copper wire alone and a not very highly-trained person simply disregarded the coefficient? If the instrument were wound with copper it might read 5 per cent. too low in the engine-room and 4 per cent. too high outside. Mr. Swinburne mentioned, amongst other things, the fact that the mutual induction between the coils increased the self-induction of the instrument, and that, therefore, it was not available for measuring alternating currents. They did not put the instrument forward as a means of measuring alternating currents, and he was perfectly well aware that an instrument of this type was not available for that purpose. As a matter of fact, when the alternations were not very great, the accuracy was just the same. Colonel Armstrong asked what degree of accuracy could be expected from the instruments. The great object they had in view in designing them was to make a portable standard which should be free from the objections which undoubtedly attached to instruments in which iron was used. It was possible to take a reading in the neigbourhood of 100 to about a quarter of a volt, or perhaps a little less. The instruments were intended

to be sensible to one part in 400 or 500 in that part of the scale in which they would probably be most used. Mr. Spagnoletti wished to know to what extent the instruments had been practically used. They were not in the hands of the public yet, but they had been very thoroughly tested, and they were satisfied that they had a portable and convenient form of dynamometer, which was portable in the sense that there were no mercury cups to be filled. Although in its present form it could not be used for marine purposes, or where a perfectly steady table could not be secured, nevertheless, they were in the way of getting over that objection, and hoped to be able to produce an instrument before long which would be free from any necessity of levelling. Mr. Gümpel had made use of a very sweeping criticism, indeed. He (Dr. Fleming) could only submit his instruments to the criticism of those who were under the necessity of using voltmeters, and by their verdict stand or fall. One word upon the beautiful instruments of Profs. Ayrton and Perry. He believed Prof. Ayrton's paper commenced with a remark that the advantage of using an instrument in which the heating quality of the current was employed to measure its quantity. He could hardly imagine that to be the case. The point of compensation (?) of the case seemed to be a very low one indeed, and although he did not yet fully understand the instrument he could not see how the position was affected.

Prof. AYRTON said they had not referred to the instrument of Sir William Siemens in the paper, for the reason that they did not wish to imply that Capt. Cardew had been anticipated or to detract in any way from the credit due to him for devising his instrument for the measurement of volts. At the time Sir William Siemens was working at this subject M. Hospitalier also was engaged upon it, and he brought forward an instrument which they had omitted to mention for the same reason which deterred them from referring to that of Sir William Siemens. They did not know of Capt. Cardew's experimental instrument upon the same lines as their own until the last meeting, but he took an opportunity in reading the paper to refer to the information which Capt. Cardew then gave him, that he had thought of using the alteration of the sag of the wire for the purpose of measuring volts; but as Capt. Cardew himself said, without some such arrangement as the magnifying spring, it was impossible to use that principle to make a commercial instrument. He was rather inclined to agree with Mr. Swinburne that such arrangements as those introduced by Dr. Fleming were not quite entitled to the name of direct-reading. He thought they ought to keep the name "direct-reading" to an instrument which indicated, without being touched, the things measured in exactly the same way that a clock indicated time. As to the use of a wattmeter, Mr. Esson thought it was unnecessary for measuring direct currents, and he was rather inclined to agree with him. The wattmeter pre-supposed some difficulty in the observer to make some simple arithmetical calculation. The first wattmeters used in this country were made by his colleague and himself, and the manner in which they were made public was rather interesting. There were two papers to be read at the meeting of the British Association in 1881, one by Sir William Thomson and the other by his (Prof. Ayrton's) colleague (Prof. Perry) and himself. As a matter of fact, in order their paper came first and Sir William Thomson's second in the printed list, but Sir William Thomson, who was presiding, had to attend a committee meeting, and asked them if they had any objection to his reading his paper first. They had none, and Sir William read his paper, and described without showing any instruments the principle of the wattmeter. He then called upon them to read their paper, but he (Prof. Ayrton) replied that Sir William had already read it, and nothing remained for them but to show the instruments, which were upon the table. With regard to the question of priority, Sir William, of course, was first to give a description of the instrument, and they could only jocularly reply that they had the instrument itself whilst he only had the idea. He (Prof. Ayrton) had no experience of Sir William Thomson's current meter on the table; it was no doubt like all his instruments, extremely beautiful and accurate, but such instruments as these aimed at obtaining a totally different sort of result from those which they (Profs. Ayrton and Perry) had from time to time brought before the society. There was the same difference between that instrument and others on the table as there was between the astronomical clock at Greenwich and the watches they carried in their pockets. With reference to the fuse, the wire sent was ·4 mills. The finest wire used for the expanding wire was 1·4 mills, in some instruments it was ·002 mills. Now, although this was much finer than the wire Captain Cardew employed generally in his voltmeters, viz., ·0025 mills., it was nevertheless much thicker than fuse wire, so that there was no difficulty on that head. He had forgotten to mention that there was a pretty device with reference to the fuse, due to Mr. Butcher, consisting of a rotating head, which contained a number of fuses, each one being of precisely the same resistance as the others. With this arrangement there was not the disadvantage found with Captain Cardew's instrument of having to put a new wire in. Every one was carefully adjusted, and the sensibility of the instrument was the same with any fuse. If the fuse went whilst it was in use it was simply necessary to turn a pivot-rotating arrangement round, and that could be repeated six times.

The PRESIDENT asked whether that form of dynamometer could be used on board any electrical launch?

Prof. AYRTON: Certainly.

The PRESIDENT: In any kind of weather?

Prof. AYRTON: Yes. In any kind of weather, fair or rough; any weather suitable for yachting was suitable for that instrument. With regard to the question of repeated contraction, Captain Cardew, like many others, had suffered a great deal from the want of knowledge of the instrument makers. If they put a platinum silver wire in an instrument, strained it, and then calibrated it by volts, and then calibrated it again, they would get totally different results. The wire should be stretched for a long time after repeated heatings and coolings before any calibration was taken. In connection with this matter a number of experiments had been carried out at the Central Institution, and it was for that reason they had not introduced the compensation—which was quite easy to introduce. In order to introduce that compensation with certainty they required to know this fact: What is exactly the coefficient of expansion of the platinum silver under considerable tension. That acquired, there was not the slightest difficulty in compensating these instruments. So far from any question of temperature having escaped their notice, some experiments had been made with those instruments in which they were warmed up for ten hours at a time to many degrees centigrade, and they knew exactly the change of zero and of sensibility with temperature. The change at zero was about half a degree, or one degree. That was very small. In one instrument there was no change of sensibility. As they would observe, instruments had been placed vertically instead of horizontally. A great deal had been said about the pointers not being visible enough; but people forget that a watch was a very useful instrument, despite the fact that they could not see the hands at forty yards distance. Mr. Evershed had raised some interesting points as to the power expended with different wires, and to these and other questions raised he would reply in his written answer. At the last meeting an impression might have been introduced in the minds of some that he had brought an old specimen of the Cardew voltmeter with the idea of disparaging Captain Cardew's voltmeter. Nothing was further from his mind. He was under the impression that he was bringing a new form. He bought it as a new form. It had taken many months to make, had cost a lot of money, and had been sold to him as the most improved form of Cardew voltmeter.

The PRESIDENT proposed a vote of thanks to the gentlemen who had so kindly read papers, producing so lively a discussion, and it was carried unanimously by acclamation.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

13978. "Improvements in coupling two or more alternate current dynamo-electric machines with a main circuit and apparatus therefor." C. D. ABEL. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated October 30. 8d. Relates to the apparatus described on another page.

1887.

5717. "An improved method of and apparatus for electrical signalling, chiefly designed for use in connection with submarine cables." H. H. LAKE. (Communicated from abroad by M. G. Farmer, of America.) Dated April 19. 8d. Relates chiefly to the use of a telephonic receiver. The claims are 8 in number.

6363. "Improvements in or connected with central telephone stations or exchanges." G. F. REDFERN. (Communicated from abroad by G. Lagache of Paris.) Dated April 30. 11d. Claims:—1. The central telephone exchange apparatus for establishing binary or multiple telephonic communications simultaneously or not between several telephone stations or subscribers, the parts of which apparatus can be operated by the attendant in the exchange and which are arranged entirely or partially in a horizontal position, substantially as described and illustrated in the drawings. 2. A commutator for electric currents of circular form having its pivot insulated and provided outside with an operating button or knob and with an indicating hand, and inside with a double pointer having its two arms of unequal lengths whereby it can be placed in communication simultaneously with contact makers placed at unequal distances from the centre, the constancy of such communication being insured by a spiral spring and all the metallic parts of a commutator, connected with the electric circuits being situated exclusively in the interior of the apparatus. 3. In a central telephone exchange apparatus, the arrangement whereby the coils of each annunciator are short circuited when its operation is to be interrupted instead of its being withdrawn from the circuit as is usually done.

6676. "Improvements in appliances for supporting, connecting and protecting electric wires." A. J. BOULT. (Communicated from abroad by E. McEvoy, of New York.) Dated May 6. 8d. Its objects are to provide in one and the same device, a holder or carrier for the main supply wires, a support for the tap wires, a means of tapping the main wires and establishing connection between them and the tap wires, and a means of automatically breaking said connection when the main wires become overheated or are so injured as to threaten the destruction of the tap wires. The claims are 2 in number.

6957. "An improved telephonic apparatus." C. L. W. FITZGERALD. Dated May 12. 6d. According to the invention the transmitter is supported in a horizontal or vertical, but preferably in an inclined position upon brackets or supports extending from a base of wood, ebonite, or other suitable material which carries also the bell and push piece, or equivalent signalling and calling devices, the bell or the like being situated under or behind the transmitter, and between the brackets or supports thereof. The switch hook for the receiver by which switch the change is made from the circuit for the bell, or the like to that of the telephones, is passed through the base and is situated preferably under the bell or the like and transmitter. The base is preferably circular and forms a box within which are contained the various contacts and devices usual in telephones, but arranged so as to fit into the said box, the terminals for the circuits being fixed to the said box or hollow base. For long lines an induction coil may be used which is then placed in the said box or hollow base. There is 1 claim.

7431. "Improvements in or relating to electric clocks." A. J. BOULT. (Communicated from abroad by M. Engelhardt of Leipsic.) Dated May 21. 8d. In the improved clock the motive force is not electricity but a spring by which also the oscillation of the pendulum is regulated. The pendulum receives its impetus exactly every minute or half minute, according to whether the clock is to indicate seconds or half seconds. The claims are 5 in number.

7527. "Improvements in electric motors or dynamo-electric machines." R. M. HUNTER. Dated May 25. 1s. 1d. The invention embodies first: a peculiar construction of field magnet and method of coupling up the coils thereof; also the means of regulating the power of such magnets. Second: an automatic device for shifting the brushes or commutator, changing the lead of the former with reference to the latter in reversing the motor. The act of reversing the current in the armature circuit simultaneously and automatically operates to shift the lead. As the armature itself acts as a magnet, the magnetic lines of force in the field will deviate upon reversing the motor, and will take an angular position different from that assumed when the motor is running the other way. The diameter of commutation is substantially at right angles to the resultant lines of force in machines like the Gramme and Siemens, and parallel, and with such lines in the Brush type, and these diameters of commutation will be shifted upon reversing the motor, and this shaft or lead will depend upon the intensity of the magnetic field and strength of current in the armature. Third: a motor with independent field magnet and armature circuits, in which may be means to change the strength of the field magnets, and modify the resistance of the armature circuit. Fourth: an armature with its coils subdivided, the subdivisions in each main coil being coupled together in multiple arc connection, and the main coils in series. The claims are 57 (!) in number.

CORRESPONDENCE.

Novel Form of Arc Lamp.

I have to thank Mr. Blanchard for calling my attention to patent No. 9,325 for 1885, which certainly does apply the electrolysis of gases to the regulation of arc lamps.

Living at a distance from London, I had to trust to the researches of others in the Patent Office Library, and I find no reason for complaint, since the method described in the patent alluded to was tried by me and discarded, as I found the results eminently unsatisfactory, and came to the conclusion that the chief effect of a lamp made on these lines would be the destruction of the dynamo.

Hence it is hardly necessary to remark that my lamp (which is only one of the many applications of the system which the patent covers) is constructed on a different principle, and requires neither solenoid nor electro-magnet.

I need say no more, as the particulars will be published in due course.

W. Hamilton.

The House-to-House Electric Light Supply Company, Limited.

I respond most willingly to your courteous invitation to explain the intended *modus operandi* of the above company. I have pleasure in informing you that the supposition that the householders will have to supply any portion of the capital is an erroneous one, and availing ourselves of your kind hint, we will take care that in any future announcements it will be made clear that where 50 or 100 householders are willing to use a combined total of 2,000 lights in one district, the company will be willing to provide the whole of the capital necessary to laying down the requisite plant for a central station, provided, of course, that the district be one which holds out a prospect of further business beyond the 50 initial subscribers, and that the demands do not exceed our available capital.

It is quite true, as your anonymous friend says, that any group of gentlemen who are willing to subscribe £10,000 can set on foot their own electric lighting scheme, but it is felt that much economy in management and in many other directions will be obtained by these various groups being combined into one large company. As a matter of fact, it has been evident, for some time past, that such a combined operation was advantageous, but where in one single case has such a group been formed?

Personally, I cannot yield to your anonymous friend as more devoted to the cause of electric lighting than myself, and I am sorry to disagree with him as to electric lighting being damaged by the above company being successfully floated. Our idea is that if it once be made evident in England that a house-to-house supply company that does not begin its career by paying away huge sums for patents and huge sums for promoters, can be an industrial success, then the example that we have started in London will be followed in various parts of the country.

In claiming as much, or even more, devotion to the cause of electric lighting than your anonymous friend, I take the liberty of pointing out to you that personally I have in one direction done more than he, for I have invested my money and employed my time for some time past in working out a house-to-house supply system in Brighton and Eastbourne, and the present company has not been founded until the results in these places have proved satisfactory.

As the personal question forms such a leading portion of your article, I venture to occupy a few more lines of your valuable space with it, and to say that your friend sadly maligns me in classing me among the promoters of electric lighting *companies*. Prior to the electric lighting *furore* of 1883, I turned my private business, based upon the "Brush" concessions for the North of England, into a limited company, which became unsuccessful by adopting the policy of purchasing patents and running manufacturing works, which policy the present company will avoid. I presume your friend in speaking of me is speaking of one whom he does not know personally; if, however, I am mistaken and he does so know me, I must urge that he has formed as superficial a view of my character as of my Christian name, which I notice he considers as John instead of

Robert Hammond.

January 23rd, 1888.

Springs on Telegraph Wires.

Apropos of your extract from *La Lumière Electrique* in a recent number of your journal, the following communication, which I sent to the *Times* last October, but which I believe was not published, may interest some of your readers.

Referring to Messrs. Shakespeare and Krause's respective communications regarding the "Humming of Telephone Wires," I gave the following additional remedies for the annoyance.

1. Wind a piece of narrow lead strip firmly round the wire for about 2 feet on either side of the insulator.

2. Connect the wire to either end of a metal chain, one yard in length, the latter being secured, at its centre, to the insulator.

3. As above, only substituting the chain for a piece of India-rubber rope.

The efficiency of the above systems will be found to be in the reverse order given. The last mentioned *entirely* subdues those dulcet Eolian vibrations, which no telephone engineer can induce house-owners, whether British or foreign, to consider as a desideratum.

To the above systems I might have added that of spiral springs as given by your French contemporary, since I used this in Italy in 1881.

However, I have found the rubber rope the most efficacious, however inferior it may be as regards duration.

Alan Danvers.

Lisbon, *January 9th*, 1888.

Curative Electricity.

I can, as you appear to anticipate, give a perfectly satisfactory explanation of my letter to one C. B. Harness, dealer in "electric" sooth charms, "electric" socks, "electric" generators, "electric" ink pellets, "electric" tooth brushes, combs, and electropathic belts, "inventor" of the Léclanche battery, Kidder's and Spamer's induction coils, &c., &c.

I had been pointing out to the said dealer that the current from discs ("disses" he called them) of zinc and copper moistened with cutaneous secretion was infinitesimally small, taking the enormous resistance of the human body into consideration, and that in order to apply a continuous current of electricity the belt ought to be used only as a vehicle for an independent portable battery.

"I patented a belt with two cells in pockets at the time Mr. Lant-Carpenter was attacking me in "Health," but it doesn't sell like the disc belt," said the dealer. "Carpenter did all he could to injure me; but he made a great mistake, because he said that it was impossible to get a current of electricity from 'disses' of zinc and copper when acted on by the secretion of the skin."

At that time, my first interview with the dealer in electro-medical appliances, I had no reason to doubt his word; but I must confess that I was somewhat surprised to learn that a gentleman so well known in the scientific world as Mr. Lant-Carpenter should have made such a statement. I asked the dealer to lend me one of the belts, and that very evening I mentioned the fact to the head of the most renowned electrical test instrument manufacturing firm in the world, a gentleman who will doubtless read this correspondence.

Mr. —— said: "I tried one of the disc belts on my own body, when my skin was moist; I got a deflection on the mirror, but when my skin was perfectly dry there was no indication of a current." These were his very words.

When I reached home, I lighted my lamp, and made my experiment, noting the deflection, which I communicated to the said dealer.

Another letter followed, advising him to construct a portable battery, so that the belt would be an electrical instrument *per se*—but that communication has evidently been mislaid!

As for the statement about Mr. Carpenter, I have long known the truth, and anyone who takes an interest in this subject may read with profit the articles by W. Lant-Carpenter, B.Sc., M.S.T.E., on "Electrical Quackery," to be found in vol. i. of "Health" (1883), pp. 277, 299, 309, 324, 341, 372, and 388, when that gentleman did a good service in warning the public against the advertisers of "Bogus Electrical Belts."

The threat contained in the latter portion of your correspondent's letter must have amused you, and you might safely reply as briefly and as effectively as Mr. Labouchere did when he acknowledged the service of a writ from the same gentleman, and politely requested him to "Fire away!"

William Lynd, M.S.T.E.

I am pleased to see that you have generously opened the columns of your excellent journal to the denunciation of galvanic belt frauds. It is a pleasure to find that in the interests of science and honesty someone has been found willing to thwart men whose sole object is to make a large fortune at the hands of poor, and in the majority of cases, ignorant individuals. Newspaper editors, as a rule, will publish nothing but good of these so-called medical electricians, and I think we can account for this when we see whole columns of advertisements inserted and paid for by these unprincipled quacks. The following unique story is, I consider, worth recording:—

About six months ago a man, or rather a gentleman, borrowed a medical coil from an electrician residing in this locality, with whom I am well acquainted, on the 1s. a week system, and at the expiration of three months the coil was returned and an inferior second-hand one purchased. About three weeks after he became the owner of a coil, he circulated a large number of cards worded thus:—

"MR. ——, M.E.,
EXPERIENCED GALVANIST.
IMPROVED GALVANIC MACHINE.
EXTRAORDINARY SUCCESS!
Persons Attended at their Homes if Desired.
CHARGES STRICTLY MODERATE.
They came to him and he healed them all,
and so will I if I can.
N.B.—Galvanic Belts from 30*s. to* 60*s. made on the establishment.*"

I must mention here that this eminent M.E. didn't even know the way to connect the battery to the coil at the time my friend lent him the machine.

I sincerely trust this ignoramus in electrical matters, and men in the same category, will shortly meet the fate they deserve.

J. J.

January 24th, 1888.

Kennedy's Dynamo.

I have noticed two paragraphs in your news columns calling attention to the similarity in appearance of two dynamos made by different makers to the single bobbin dynamo made by me, and lately noticed by you in these columns.

I presume these makers wish to claim priority in the matter of design and manufacture of this form of magnet for a dynamo.

I make a variety of dynamos of which this is one form, and I may add my statement that I have had this dynamo in hand since early in 1884, having designed and made small ones then with this form of magnet, but not till now have I made up a set of patterns for all sizes from 2 units to 40 units and placed them on the market. I am pleased to see that this form of magnet has proved of sufficient interest to induce other makers to adopt it; imitation is the sincerest flattery.

Pro **Rankin Kennedy,**
ROBERT MITCHELL.

January 24th 1888.

Lamp and Dynamo Patents.

Could you give me dates and numbers of patents under which the Edison-Swan incandescent lamps are made, also for Siemens's armature, that is, as to the winding?

R. Butterworth.

[The back numbers of the REVIEW containing reports of the suit brought by the Edison-Swan Company against Messrs. Woodhouse and Rawson will probably give our correspondent part of the information he requires. As to the Siemens patent, No. 2,006, 1873, is the principal specification relating to armature winding.—EDS. ELEC. REV.]